SECRET

NIS 39A

FILE

NATIONAL INTELLIGENCE SURVEY

COMMUNIST CHINA

CHAPTER VII

SCIENTIFIC

Chapter VII of NIS 39A is issued under the NIS maintenance program. It supersedes the material on Communist China in the original Chapter VII of NIS 39, issued January 1955. Communist China was designated NIS Area 39A and subsequent revisions of NIS units on that area will be so designated.

CENTRAL INTELLIGENCE AGENCY

Washington, D. C.

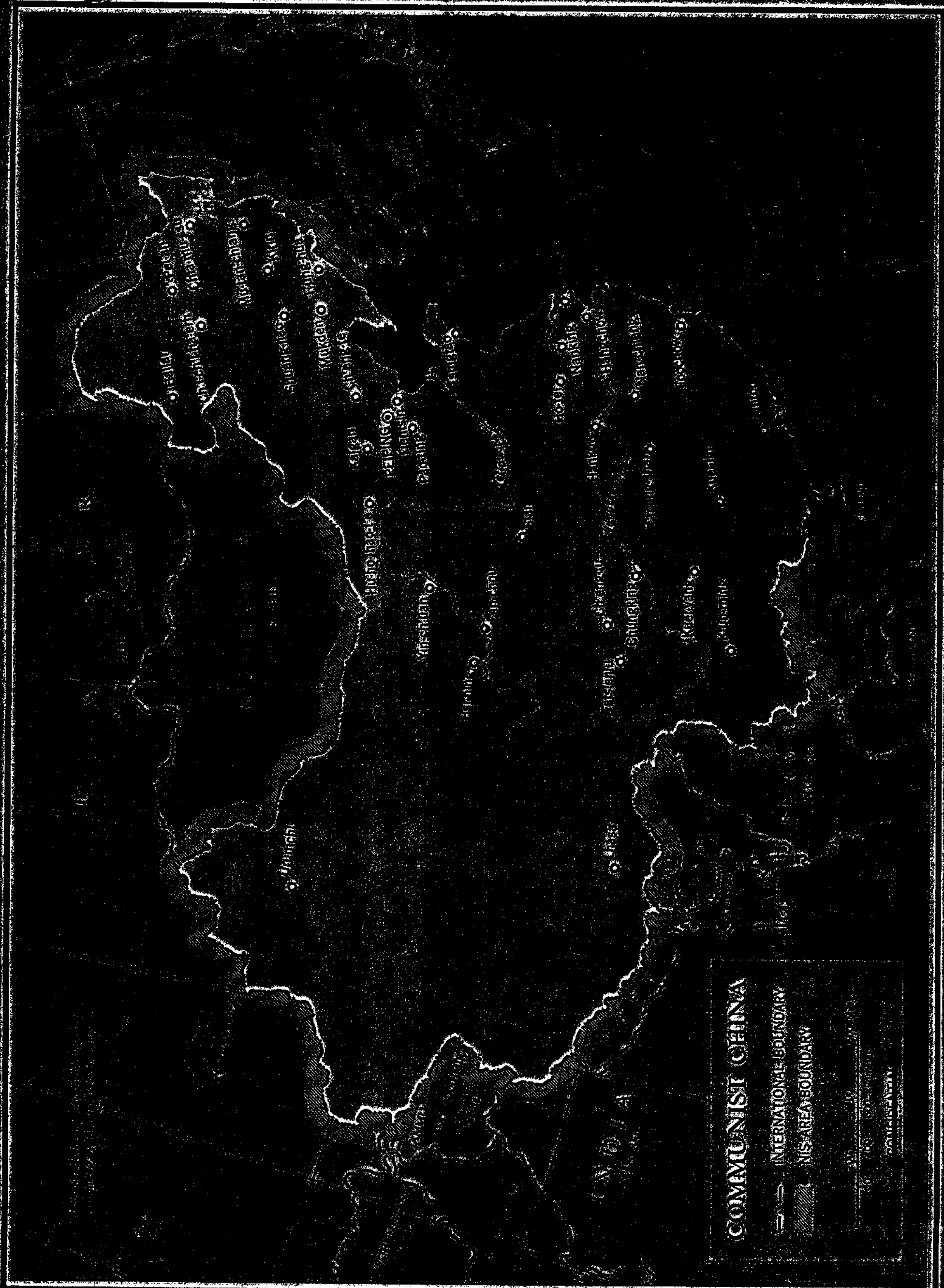
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TABLE OF CONTENTS FOR CHAPTER VII

Section 70. Introduction

This Section was prepared for the NIS by the Central Intelligence Agency, with assistance or contributions from the Bureau of Intelligence and Research, Department of State; the Office of the Assistant Chief of Staff for Intelligence, Headquarters, Department of the Army; the Office of Naval Intelligence; and the Office of the Assistant Chief of Staff, Intelligence, USAF. It was coordinated by the Scientific Intelligence Committee.

Section 71. Electronics

This Section was prepared for the NIS by the Office of Naval Intelligence, with contributions from the Office of the Assistant Chief of Staff for Intelligence, Headquarters, Department of the Army, and the Office of the Assistant Chief of Staff, Intelligence, USAF, and with assistance from the Central Intelligence Agency. It was coordinated by the Scientific Intelligence Committee.

Section 72. Air, Ground, and Naval Weapons

This Section was prepared for the NIS by the Office of the Assistant Chief of Staff, Intelligence, USAF, with contributions from the Office of the Assistant Chief of Staff for Intelligence, Headquarters, Department of the Army, and the Office of Naval Intelligence, and with assistance from the Central Intelligence Agency. It was coordinated by the Scientific Intelligence Committee. Information on guided missiles was coordinated by the Guided Missile and Astronautics Intelligence Committee.

Section 73. Atomic Energy

This Section was prepared for the NIS by the Central Intelligence Agency, with assistance or contributions from the Bureau of Intelligence and Research, Department of State; the Office of the Assistant Chief of Staff for Intelligence, Headquarters, Department of the Army; the Office of Naval Intelligence; the Office of the Assistant Chief of Staff, Intelligence, USAF; and the Atomic Energy Commission. It was coordinated by the Joint Atomic Energy Intelligence Committee.

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This Section was prepared for the NIS under the general supervision of the Office of the Assistant Chief of Staff for Intelligence, Headquarters, Department of the Army, by the Office of the Chief Chemical Officer, with assistance from the Office of Naval Intelligence; the Office of the Assistant Chief of Staff, Intelligence, USAF; and the Central Intelligence Agency. It was coordinated by the Scientific Intelligence Committee.

Section 76. Physical Sciences, Mathematics, and Medicine

This Section was prepared for the NIS by the Central Intelligence Agency, with assistance or contributions from the Bureau of Intelligence and Research, Department of State; the Office of the Assistant Chief of Staff for Intelligence, Headquarters, Department of the Army; the Office of Naval Intelligence; and the Office of the Assistant Chief of Staff, Intelligence, USAF. It was coordinated by the Scientific Intelligence Committee.

LIST OF FIGURES

Guide to Users

Chapter VII of NIS 39A describes and evaluates scientific research in Communist China and the development of materiel through the prototype stage. Related descriptions of existing and potential industrial support, manufacturing, and budgetary appropriations may be found in Chapter VI of this NIS. Chapter VIII discusses military use of materiel. The user may find further data on scientific personnel in Key Personalities

Maps showing the locations of scientific and technical activities in specialized fields accompany most Sections. Where appropriate, glossaries of scientific and technical organizations, showing names in English and Chinese, are also included.

Standard Telegraphic Code (STC) numbers, numerical representations of Chinese characters, are given for the names of those individuals and organizations mentioned where Chinese characters are available.

The date that the Scientific Intelligence Committee approved the material for use in the NIS appears at the top of each page. Although research on some of the subjects may have been completed somewhat earlier, the conclusions presented are considered to be valid at the time of approval.

70. Introduction

A. Evaluation and development of the scientific effort

1. Present status and recent trends

Communist China has a relatively large research and development establishment, capable of providing limited but effective support in nearly all technical areas connected with the regime's program for building a modern industrial and military establishment. Competence is generally adequate for understanding the technology involved in the plants, processes, and systems supplied by foreign countries, thus providing the regime with some opportunity for planning and operating without complete dependence on the Soviet Union. Chinese scientific and technical personnel are capable of supplying most technical services needed to maintain and improve operations in industry, agriculture, public health services, natural resources development, and the military services. Most research and development work is carried out well within the current state of the art found in scientifically advanced countries. A shortage of well-trained scientists capable of the planning, supervising, or carrying out of advanced and complex projects stringently limits the number of such projects, although the country has a number of very talented researchers capable of producing significant results.

Research and development work has the full support of the government and is organized in what appears to be an effective system for planning, coordinating, and supervising a national research effort. Emphasis is placed on those technological fields which the regime believes will most rapidly enhance national power. Atomic energy receives first priority; other fields include electronics, jet engines, metallurgy, and public health. Current research emphasis is on fulfilling technological goals. Nevertheless, the value of fundamental science is believed to be well understood by the regime and the present Twelve-Year Plan for science development (1956–67) provides for some effort in this area. In mid-1960, a trend toward more specific backing and programming of fundamental research was becoming evident. As the number of capable engineers and technicians increases, the few scientists capable of work of a more advanced nature in research and development will be used less for routine engineering and technical work.

Facilities and personnel are gradually increasing. Budgets for science have increased ten times between 1955 and 1960, when the science budget constituted 1.55% of the total national budget. The area critical to future progress is the training of new scientists capable of work at advanced levels and eventually working into areas of new scientific knowledge and technological developments. Programs for the training of such researchers in China only recently have reached what appears to be an effective level; as a consequence, few capable scientists have been trained to date in China. Current programs of training appear to be capable of producing well-trained new researchers at an appreciable rate in from five to ten years. Most new capable scientists have received their training in the Soviet Union. Soviet-trained young scientists, though relatively inexperienced, constitute a sizeable proportion of the better trained researchers available.

The allocation of resources between military and civilian research and development is not known, but an effort of direct military interest, particularly in atomic energy, is progressing. It is presumed that most resources are being allocated for research and development in support of basic industrial areas that constitute the ultimate foundation for national power, including its military component.

2. Historical background

Before the era of modern science, China's achievements of a scientific and technical nature were comparable to or greater than those made in other great centers of civilization. A number of discoveries or developments were made by Chinese many centuries before their rediscovery or introduction elsewhere. Well-known Chinese inventions and developments include the compass, paper, printing, movable type, silk, porcelain, and gun powder. Other examples of Chinese technical developments during their three or four thousand year history include achievements in bronze and cast iron technology, and such developments as an iron-chain suspension bridge, a cross-bow, canal-lock gates, blowers for metallurgical use, efficient animal harnesses, and the sternpost rudder. In medicine, Chinese development of mineral and botanical specifics is famous. Recent historical research credits the Chinese with the development of a mechanical escapement for water-powered clocks several centuries before the European development of the mechanical escapement. These few examples, plus the extensive engineering works such as China's famous canals, roads, and fortifications—some dating from the 15th century B.C.—show a long tradition for the development of technical devices, processes and works. In addition to such technical developments, a number of fields of knowledge such as mineralogy, botany, entomology, astronomy, geophysics, and mathematics came under varying degrees of systematic study. Extensive mathematical literature as well as astronomical and seismic records and instruments show a level of development that compares favorably or exceeds the accomplishments elsewhere up to the time when such Europeans as Bruno, Copernicus and Galileo sparked a new era of scientific and technical advance.

At the turn of the 17th century, commonly considered the advent of the era of modern science, China's understanding and use of the forces and materials of nature were no less well-developed in most fields than those in western Europe. For various political, economic, or physical-geographical reasons, it was in western Europe and not in China or elsewhere that science and technology began to grow and gather the momentum that ultimately made it the dominating factor of civilization today.

As long as 100 years ago, some Chinese began to become aware of the growth of western science and technology but, in the following century of turmoil and revolution, the conditions in China were unfavorable for promoting science and technology as was done so successfully in Japan. By the turn of the 20th century, however, some effort to do so was clearly recognizable. Peking and Futan Universities were founded about 1900 and Tsinghua was founded in 1911. Since the founding of the republic in 1912, there has been a persistent effort and a gradual growth in scientific and engineering education and research despite the discouraging conditions. The following well-known universities were founded as follows: Nank'ai in 1919, Amoy in 1921, Chungshan in 1924, Wuhan in 1928, and Yünnan in 1931. In 1928, the *Academia Sinica* was founded in Nanking to serve as the national academic body; it was supported by the government but was relatively free of government supervision, being responsible only to the president of the republic. It was not only an honorary body but one actively engaged in directing and coordinating research work and operating its own research institutes. In 1929, the National Academy in Peiping was founded under the auspices of the Education Ministry to serve the same purpose as the *Academia Sinica,* except that its location at Peiping represented a kind of advanced echelon in an area of the country where Nationalist control was somewhat less assured. Research bodies operated by the government included the National Agricultural Research Bureau and the National Industrial Research Bureau, the latter's interests covering almost all aspects of technology. A number of private research institutes supported by both Chinese and foreigners were also in existence during the period of the Nationalist control of mainland China. Scientific societies were also organized during this period: Science Society of China (1914), Chinese Engineering Society (1919), Chemical Society of China (1932), and Agricultural Society of China (1925). Societies were commonly founded by students while studying abroad. The societies were active in setting up and operating libraries and laboratories and publishing journals. By 1936, there were 53 societies and research institutes for the natural sciences and 67 for the applied sciences.

The government of China under the Nationalists fully understood the value of the promotion of science and technology and planned for its expansion along with its planning for industrial development to be carried out as soon as cessation of wars and insurrections could offer a period of stability. This came, however, only with the takeover of the mainland by the Communists. By this time, the Chinese under the Nationalists had attained experience in operating universities and research laboratories, organizing and managing national bodies of science, developing and operating government laboratories and research planning bodies, and most important, had supported or encouraged the training of a nucleus of several hundred very capable scientists and a few thousand other scientists capable of useful research and development work. By 1947, there were some 215 higher educational institutions in China with an enrollment of 155,000. The Communists took over these assets and carried forward the Chinese plans to develop science and technology for the support of rapid industrialization and the growth of national power.

The scientific and technically trained leaders available to the Communist regime to commence its effort to advance research and development capabilities were nearly all trained in such countries as the United States, United Kingdom, France, and Germany, and many had international reputations in their fields. Some of China's well-trained scientists were in China at the time of the Communist takeover and an appreciable number have returned since that time. Probably an equal number of well-trained Chinese scientists have remained abroad or accompanied the Nationalist government to Taiwan.

In November 1949, one month after the establishment of the Communist regime, the *Academia Sinica's* assets, left behind after its withdrawal to Taiwan, were combined with those of the National Academy at Peiping to form the Communists' Chinese Academy of Sciences. The *Academia Sinica* continues its existence on Taiwan. In the eleven years following the Communist takeover, the Academy of Sciences has grown from a few hundred researchers to an estimated 7,000. The number of research organizations under the technical ministries has increased at a similar rate. The years 1950–55 were devoted largely to reorganizing the educational and research establishment. Next followed two years largely spent in planning, with Soviet aid and guidance, a long-range program for the general advancement of science, with particular attention given to advancement in specified technological fields. By 1958, significant research and development activity was underway, although training of new scientists continued to be a major task of Communist China's scientists.

B. Organization and functioning of the research program

1. General supervision and guidance

Research and development in Communist China is carried out in government operated institutions in accordance with detailed yearly and long-range plans. Overall planning, control, and supervision of all research and development activities are vested in the (State) Scientific and Technological Commission (*K'o-hsueh Chi-shu Wei-yuan-hui*) of the State Council, although ultimate control rests with the Chinese Communist Party (CCP) (see FIGURE 70–1). Most significant among these in actual conduct of research is the Chinese Academy of Sciences. Important work is also conducted by the research organs of the technical ministries and by the universities and colleges. Of considerably less importance is the work of the research organs of the provincial governments and other lower political units. In the preparation of plans and work programs individual researchers and higher research units are expected to participate and exercise judgment, but all plans and programs must conform to the planning and coordination requirements of successively higher authority. Plans generally must conform to the national

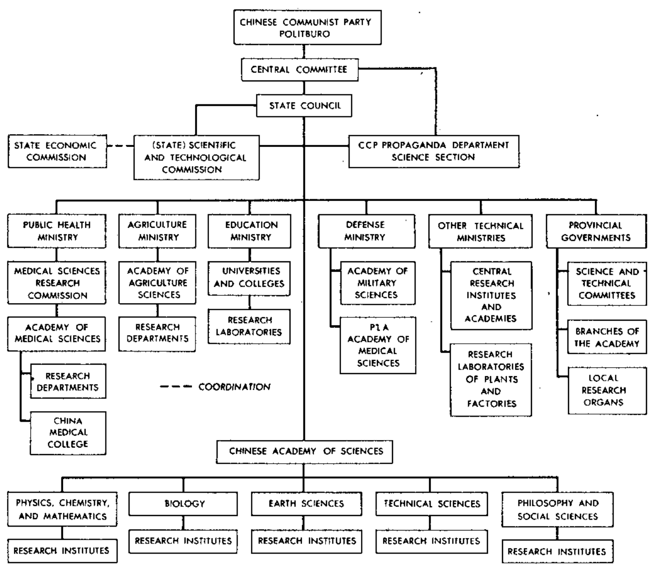


FIGURE 70–1. ORGANIZATION OF SCIENCE, COMMUNIST CHINA

Twelve Year Plan for Scientific Development (1956–67).

The CCP establishes basic policies for the scientific and technological effort and dominates the work through party officials placed in key positions in research organs and through Party Committees set up at all levels of the research establishment. Decisions on broad policy matters in science and technology are made at high levels in the Party, including the Politburo. The Party's office regularly overseeing scientific affairs is the Science Section of the Central Committee's Propaganda Department. The Party's mass control organization in the field of science and technology is the Scientific and Technological Association of the People's Republic of China (*Chung-hua Jen-min Kung-ho-kuo K'o-hsueh Chi-shu Hsieh-hui*) to which belong all scientists, technologists, engineers, and teachers of scientific and technical subjects and many others connected with technical affairs. This association was formed in September 1958 by amalgamating the All-China Federation of Scientific Societies and the All-China Association for the Popularization of Science and Technology.

The (State) Scientific and Technological Commission, the government's overall planning and controlling body for science and technology, is under the State Council. Its chairman is a member of the State Council along with the heads of other commissions and the various ministries. The commission is responsible for determining the level of technology that should be sought in various technical areas of the economy and for determining the research and development effort that should be made to foster the introduction of new technology or the achievement of particular scientific objectives. The commission works in close conjunction with the State Planning Commission (*Kuo-chia Chi-hua Wei-yuan-hui*) for long-range planning and the State Economic Commission (*Kuo-chia Ching-chi Wei-yuan-hui*) for annual planning. In addition to its planning role the Scientific and Technological Commission is responsible for coordinating and generally supervising the entire research and development effort. The commission's role calls for close collaboration with the organizations responsible for scientific and technological operations, viz, the various technical ministries, the Education Ministry, and the Chinese Academy of Sciences (*Chung-kuo K'o-hsueh-yuan*), AS, Peiping.

The Scientific and Technological Commission has 11 members and over 30 divisions, each responsible for a particular field of technology, basic science, or some other aspect of science and technology such as training, equipment and supplies, and scientific information. The divisions are believed to include the following and possibly others:

Agriculture	Light industry
Apparatus and supplies	Machine building
Atomic energy	Medicine
Aviation	Metallurgy
Comprehensive geographic area surveys	Meteorology
Computer techniques	Oceanography
Construction	Petroleum and coal
Defense problems	Power
Electricity	Radio and electrical engineering
Forestry	Scientific information
Fundamental sciences	Scientific personnel
Geology and mineral products	Supersonic techniques
Heavy chemical engineering	Surveying and mapmaking
Hydraulic engineering	Textiles
Inorganic chemical engineering	Traffic and transport
International scientific affairs	Training
	Weights and measures

The commission has no research facilities within its own organization but does have some operational responsibilities connected with scientific personnel, research materials, weights and measures, scientific information, and international scientific affairs.

The AS exercises considerable influence over science and technology. It probably is a principal and effective advisor to the Scientific and Technological Commission and provides considerable academic leadership for all research and development establishments, as well as for institutes of higher education in connection with their scientific and engineering courses and their research work. The academy does not, however, have any administrative control over any organization outside its own structure.

Planning of scientific and technological work is centered in the Scientific and Technological Commission. Its work is done under broad policies adopted at high levels in the Party and presumably passed down formally through government channels. Since research and development work is only a part of the overall national effort to reach economic and military objectives, research and development planning is intimately connected with those objectives. For this reason, the Scientific and Technological Commission works in conjunction with the State Economic Commission, the State Council's body responsible for preparing the yearly plan for production and various economic services. The Scientific and Technological Commission also may be expected to assist the State Planning Commission in long-range planning. There are no clear indications, however, of the formal channels or mechanism by which coordination and interaction between these commissions are effected. The Scientific and Technological Commission probably supplies high Party officials with scientific and technological opinion bearing on policymaking and would be the most likely body to submit policy proposals in the scientific and technological field to top Party policymaking bodies, including the Politburo.

With research and development aims intimately tied to economic and military objectives, applied research is emphasized. Nevertheless, it is believed that much fundamental research will also come under planning, at least to the extent of choosing research areas where there is an obvious or likely connection with technological fields and where prospects for rewarding new developments are promising.

The foundation for operational planning at all levels is the Twelve Year Plan for Science Development (1956–67). This plan had its conception in late 1955. The determination of its broad objectives, based as much on political, economic, and military criteria as on scientific and technical, was a Party responsibility with the Politburo the final approving body. The plan was worked out in detail during 1956 under the Science Planning Committee set up for the purpose in March 1956. To accomplish the planning task, the committee mobilized most of the capable scientists in China; the work occupied most of them for several months and many of them for a good part of a year. Soviet experts also assisted in the planning work, probably to a very significant degree.

The plan has two basic aspects: 1) raising capabilities in eleven technological fields considered most important to Communist China's ambitions; and 2) raising general capabilities in the various fields of science to world levels.

Technological fields designated for emphasis are as follows:

- Atomic energy
- Electronics (includes radio, computers, instruments, semiconductors)
- Jet propulsion
- Automation and precision instruments
- Exploration for petroleum and other minerals
- Alloy systems and metallurgical processes
- Fuel utilization and heavy organic synthesis
- Power equipment and heavy machinery
- Yellow and Yangtse River development
- Agriculture (mechanization, electrification, agricultural chemicals)
- Major endemic diseases

A twelfth broad area for concentration includes particular subjects of basic research, such as solid state physics, nonlinear differential equations, and the structure, function, and synthesis of proteins. The basic science subjects appear to have been selected for their promise to provide early or outstanding contributions to applications in priority fields. The general objective of these specified fields is to attain research and development capabilities necessary to handle all the technical problems arising in industry, agriculture, and other technical aspects of the economy.

The second part of the plan is intended to raise the general level of competence in most areas of the natural sciences to world levels by the end of 1967 in order to provide the scientific foundation for moving forward into new technological realms and being on competitive terms in many areas with other countries of the world. This part of the plan is not connected with specific technological objectives but rather to the general strengthening of scientific foundations.

The first or technological part of the plan was broken down into 57 broad working programs, the latter two including the special basic science subjects and the task of setting up a scientific documentation center. These working programs were further divided into 582 projects, the details of which are not available.

Using the Twelve-Year Plan as the basis, research organs such as the AS and ministry research and development organizations set forth their yearly objectives in relatively broad terms. These are elaborated in progressively increasing detail as they pass from top echelons down through the various administrative levels to the individual scientists or research teams. Work projects for carrying out the objectives are developed for each research group within research institutes and are passed up through channels for collation and coordination. As far as reasonable, the AS is expected to coordinate its planning with the needs of the technical ministries. Universities and colleges to some extent associate their research work with nearby factories, farms, mines, etc., and presumably consider the problems of such organizations in their planning work. The academy, ministries, and possibly provincial governments submit their plans to the State Scientific and Technological Commission for final collation and coordination. The commission prepares the overall state plan for research and development. The plan or a summary is believed to be included in the yearly National Economic Plan. Research and development work actually pursued is probably conducted generally in consonance with the yearly plan.

2. Government research organizations

a. CHINESE ACADEMY OF SCIENCES — The principal research and development organ in Communist China is the Chinese Academy of Sciences. It operates under the direction of the State Council, particularly the State Council's Scientific and Technological Commission. Although the academy is not a constituent part of the State Council, the procedures for appointment of its president and vice presidents are the same as for the heads of ministries and commissions, viz., being nominated by the premier, approved by the National People's Congress or its standing committee, and formally appointed by the Chairman of the People's Republic of China. Basic operating policies and regulations of the academy are subject to the approval of the State Council.

The academy has no control over the activities of other organs engaged in research and development, but by virtue of its concentration of capable personnel and relatively extensive facilities, it is able to exercise considerable leadership in scientific affairs.

The academy provides the government with a reservoir of scientific competence on which it can draw for assistance and guidance in planning and upon which it relies for the major portion of its research and development. The academy is responsible for conducting major comprehensive and relatively long-range projects, keeping abreast of world technological developments and conducting fundamental research. Most of its work is applied research in direct support of production and various economic services, and some actual production is done in small attached plants. A major additional responsibility of the academy is the training of new scientists, a responsibility it shares with the Ministry of Education (*Chiao-yu Pu*).

The headquarters of the academy is located in the middle of Peiping, and many of the academy's research institutes are located in Peiping. An extensive new compound of laboratories and living quarters has been built some four miles northwest of the walled city as part of the so-called cultural center, which includes Peiping and Tsinghua Universities and numerous technical colleges. (FIGURE 70–2 shows a research building of the AS.) Similar new large research centers are being established at Sian and Lan-chou. Other concentrations of academy facilities are found in Shanghai, Nanking, Ch'ang-chu'un, and Shen-yang.

The organization of the academy is believed to be as shown in FIGURE 70–3. A number of new institutes, in addition to those listed in FIGURE 70–3, have been set up since 1958.

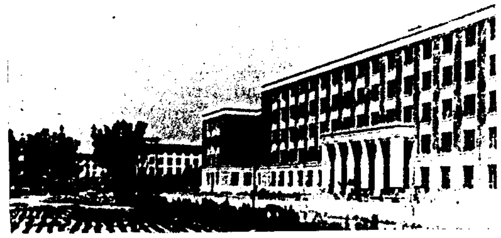


FIGURE 70–2. CHEMISTRY BUILDING, AS, 1959

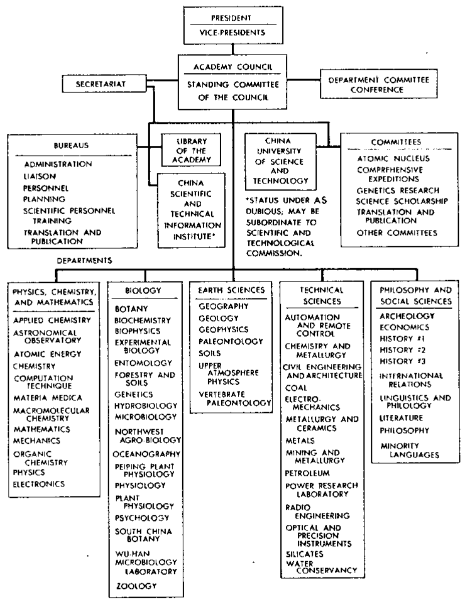


FIGURE 70–3. ORGANIZATION OF THE CHINESE ACADEMY OF SCIENCES

The formal supreme organ of power in the academy is the Academy Council of the AS, particularly in the form of its Standing Committee which in actual practice probably has power equivalent to the whole Council. The composition of the council is not known. The Standing Committee of the council may be composed of the academy's president and vice presidents plus the chief secretary—a composition that would be similar to the Standing Committee of the State Council.

Assisting the Academy Council is a Secretariat with three secretaries and five deputy secretaries. The duties of the secretariat apparently include both administrative and scientific substantive matters. The Secretariat is believed to be a fairly powerful body. On the administrative and service side are the various bureaus for personnel, scientific personnel training, planning, liaison, translation, and publication and administration. On the scientific side, are a number of committees, the Library of the Academy, the China University of Science and Technology (*Chung-kuo K'o-hsueh Chi-shu Ta-hsueh*), and the five departments under which the academy's some 100 research institutes operate.

In most cases the bureau names indicate about as much as is known about the bureau function. The Liaison Bureau is responsible for general contact with the public, universities, schools, and foreign countries. The Scientific Personnel Training Bureau, in its administration of the academy's program for the training of scientists, probably handles some affairs bearing on the academy's China University of Science and Technology, but the university is not believed to be strictly subordinate to this bureau.

The academy has formed a number of committees to handle specific subjects cutting across the interest of several departments or involving the interest of other government bodies. The Translation and Publication Committee determines policy for scientific publication, examines and approves publication plans, organizes the editing work, and generally oversees work in the field of publication and translation.

The Comprehensive Expeditions Committee handles general policy, planning, and probably operations of teams making broad surveys of mineral, power, transportation and other resources of a particular geographic area for the ultimate purpose of economic exploitation and development.

The Scientific Scholarship Committee reviews the achievements of Chinese scientists for the purpose of recommending quadrennial awards for meritorious work.

The collection and dissemination of scientific information is carried out by the Chinese Institute of Scientific and Technological Information (*Chung-kuo K'o-hsueh Chi-hsu Ch'ing-pao Yen-chiu-so*). When set up in September 1956, with the name Scientific Information Institute of the Chinese Academy of Sciences, it was clearly a part of the academy, but since the name was changed during 1959 to the China Scientific and Technical Information Institute, it may have been removed from the formal organization of the academy.

The research institutes of the academy are organized under the five departments (see FIGURE 70–3). Each department is responsible for planning, promoting, and generally supervising research operations, training programs, and publication of papers by its subordinate institutes. Each department has a department committee made up of eminent scientists, both from within the academy and from universities or elsewhere. These committee members are akin in rank to the Soviet Academician, but no such title is used in Communist China. Department committees are supposed to meet once a year and at that time all five department committees gather in a joint meeting known as the department committee conference. These committees appear to be more in the nature of a "mass" body for controlled discussion and the making of pronouncements than for substantive discussion, policymaking, or even advising. Each department committee has a standing committee consisting of the department director, the deputy directors and several other department members. The standing committee meets at least once a month and probably serves a useful advisory function.

Under the five departments are some 100 research institutes, of which many of the more important are listed in FIGURE 70–3. The names of the remainder are unknown or uncertain, having been recently created or formed from branches or sections of older institutes.

Each institute is under the domination of the Party, whose members are dispersed throughout the institute. Any institute action is subject to review by the Party committee. One of the deputy directors or even the director is usually a well-trusted Party man who is not a scientist. Some institute officials who are scientists have become Party members in recent years, but few, if any, are believed to enjoy the same degree of confidence from the regime as do the professional Party men.

The scientific committee, which operates directly under the director of an institute, is composed of scientists who are leaders in the institute's field of work. Some are researchers in the institute to which the committee is attached; others may come from other institutes of the academy or from outside the academy, particularly from universities and colleges. Unlike the department committees, the scientific committees of institutes appear to be important and active bodies. They deal with practically all substantive matters, including the preparation and coordination of research plans, examination of research results, discussion of research underway, hearing dissertations by research students, and acting in general as a forum for the discussion of all academic matters. The degree to which the scientific committees have authority is not known; they are probably more discussion and advisory bodies, but important in conducting the scientific affairs of the institutes.

Starting in 1958, branches of the academy have been set up in most provinces, autonomous regions, and centrally administered municipalities. The duties and authority of the branches are not clear. It is believed that they exercise little control or supervision over the research work done in the institutes, specifically those institutes which have been referred to by the Chinese Communists as "senior research institutes." The purpose of the many newly formed branches appears to be: 1) to promote the popularization of science and technology; and 2) especially, to promote the campaign for a mass effort to improve all work methods and products through technical innovations, to which all workers are implored to turn their attention. The branches provide an organizational structure for Party control in a field where the prestige of being associated with the academy is probably useful. The mass-movement nature of the branch purpose is suggested by the fact that each branch was organized by the local Party committee with the Party Secretary or other local political personage named as head of the branch. Hundreds of new so-called research institutes have been established at provincial and lower levels, including communes. The shortage of scientific resources in Communist China precludes the possibility that much significant scientific and technological output could result from this proliferation of research and development organizations. As part of the trend in Communist China toward decentralized control, it may be the intention that each branch is to take a leading role in all scientific and technical activity in its area, but this does not appear to be the case as yet. Decentralized authority in this field would more logically devolve to the provincial scientific and technological committees, local bodies akin to the national Scientific and Technological Commission. Strong control of all significant research and development activities appears to continue to be centered in Peiping.

Before the great expansion in numbers of branches starting in 1958, the academy had, or was reported to have set up, regional branch offices in Ch'ang-ch'un, Shanghai, Canton, Nanking, Wu-han, Sian, and Lan-chou. The branches at these locations may have provided a useful administrative function on a regional basis for the academy headquarters in Peiping; these branches may be currently more significant than the others because of the relatively large concentration of significant academy research institutes in those cities. The role of branches in academy operations has not been clearly of any great significance, but an elevation of their role could conceivably be developing.

Manpower reported to be employed by the academy at the end of 1959 totaled 40,000 persons in all categories. This force included 7,000 research workers, the remainder being in various administrative, trainee, technician, and labor categories. The number of support-type personnel has risen sharply to 33,000 from the 12,000 reported by the Communists in 1957. Many of the new personnel are members of army units which, for reasons unknown, have been demilitarized and assigned to research institutes, where they are expected to assist in the research work.

Of the 7,000 reported as professional research workers, the Communists have described some 2,500 as being scientists of renown. The implication is that this is the maximum number considered by the Communists to be capable of useful leadership in significant research work. Of these 2,500 scientists, some 800 have received doctorate-level training. The remainder have had college training of widely varying quality and extent. The 800 doctorate level researchers (not including medical doctors) include 250 trained in the United States and other Western countries and a possible 550 trained in the Soviet Union. The researchers of lower level training are products of China's universities and an estimated 200 graduates of Soviet higher educational institutions. There are probably some researchers who have had undergraduate or limited graduate training in Western colleges, but the number is not known; however, it may be in the general order of less than 1,000 out of the 2,000–3,000 of this type throughout China.

The training of new scientists has been a responsibility of the academy since its founding in November 1949, but few competent researchers had been trained up to the end of 1959. Only recently has the academy succeeded in setting up a relatively well-delineated scheme of training. By 1958, only 340 graduate students were in the academy's training program and no additional graduate students are known to have been admitted since that time. An undergraduate program was started in September 1958 with the establishment of the academy's China University of Science and Technology. Students enrolled totaled 1,600. New students are presumably admitted each year. A Shanghai branch or a separate university called the Shanghai University of Science and Technology was also set up and 300 students enrolled in 1959. In addition to these universities, the Chinese Academy announced in the summer of 1958 that it was setting up eight colleges to be located in academy research institutes. Among the eight were colleges for the study of machinery, optics and precision instruments, and chemistry in Ch'ang-ch'un; forestry and pedology in Chenyang; botanic gardening in Nanking; and geophysics in Peiping.

b. RESEARCH ORGANIZATION IN THE MINISTRIES — Each of the technical ministries conducts research and development work. Presumably, each ministry has some central office to provide overall planning, coordination, and some supervision of the ministry's research and development responsibilities. Such a central office would also be the ministry's organ for liaison with the (State) Scientific and Technological Commission. One known example of such a body is the Ministry of Public Health's Committee for Medical Research.

Actual research operations are carried out either in central research organizations of the ministries or in laboratories attached to factories, mines, or other production units. The central research organs are intended to work on key problems in particular industries, whereas plant laboratories are expected to solve plant production problems.

No standard pattern for the organization of research within the ministries has been discerned. In those cases where a number of research institutes of a ministry come under unified operational management, the term "academy" is commonly used in the name as rendered in English. Examples are the Ministry of Public Health's Chinese Academy of Medical Sciences (*Chung-kuo I-hsueh K'o-hseuh-yuan*) and the Ministry of Agriculture's Chinese Academy of Agricultural Sciences (*Chung-kuo Nung-yeh K'o-hsueh-yuan*). Both operate a number of subordinate research institutes and appear to be generally responsible for all research and development in their field throughout the country. The organizational status of these academies is probably equivalent to bureaus (*chu*) if not higher. Other known ministry academies are the Ministry of Forestry's Chinese Academy of Forestry Research (*Chung-kuo Lin-yeh K'o-hsueh Yen-chiu-yuan*) and the Ministry of Geology's Chinese Academy of Geological Research (*Chung-kuo Ti-chih K'o-hsueh Yen-chiu-yuan*). Other ministries probably also have such academy organizations for the management of their research and development operations. See FIGURE 70–4 for the principal research organs under the various ministries.

FIGURE 70–4. PRINCIPAL RESEARCH ORGANS UNDER THE VARIOUS MINISTRIES, COMMUNIST CHINA

CENTRAL BUREAU OF METEOROLOGY:
- Central Institute of Meteorological Research (*Chung-yang Ch'i-hsiang Yen-chiu-so*), Peiping.

FIRST MINISTRY OF MACHINE BUILDING INDUSTRY (*Ti-i Chi-hsieh Kung-yeh Pu*):
- Institute of Industrial Engineering and Machine Building.
- Institute of Machine Tools.
- Shanghai Scientific and Industrial Instrument Research Institute. (*Shang-hai I-ch'i I-piao K'o-hsueh Yen-chiu-so*) Shanghai.
- Institute of Aeronautical Industry.
- Institute of Automobile and Tractor Research.
- Institute of Shipbuilding Research.
- Institute of Steam Turbines and Boilers.
- Institute of Materials Utilization Research.
- Peiping Electrical Equipment Scientific Research Institute.
- Shanghai Electrical Equipment Scientific Research Institute.
- Institute of Tropical Electrical Equipment.
- Sian Electric-Ceramics Research Institute.
- Institute for Battery Research.
- Shanghai Electric Cable Research Institute.
- Institute for High Voltage Electrical Equipment.
- Institute for Electric Generators.
- Institute for Power Traction Equipment.
- Institute for Transformers.

MINISTRY OF AGRICULTURE (*Nung-yeh Pu*):
- Chinese Academy of Agricultural Sciences (*Chung-kuo Nung-yeh K'o-hsueh-yuan*), Peiping.
  - Departments of:
    - Agronomy.
    - Crop Breeding and Cultivation.
    - Plant Protection.
    - Animal Husbandry.
    - Veterinary Science.
    - Agricultural Economy.
    - Soils and Fertilizers.
  - Regional Research Institutes for
    - North, Northeast, Northwest, Central, East, South and Southwest China.
  - Other Research Institutes
    - Crop Breeding and Cultivation (*Tso-wu Yu-chung Tsai-p'ei Yen-chiu-so*).
    - Plant Protection (*Chih-wu Pao-hu Yen-chiu-so*).
    - Soils and Fertilizers (*T'u-jang Fei-liao Yen-chiu-so*).
    - Animal Husbandry (*Ch'u-mu Yen-chiu-so*).
    - Veterinary Medicine (*Shou-i Yen-chiu-so*).
    - Chinese Traditional Veterinary Medicine (*Chung-shou-i Yen-chiu-so*).
    - Utilization of Atomic Energy (*Yuan-tzu-neng Li-yung Yen-chiu-so*).
    - Sericulture (*Ts'an-yeh Yen-chiu-so*).
    - Agro-meteorology (*Nung-yeh Ch'i-hsiang Yen-chiu-so*).
    - Cotton (*Mien-hua Yen-chiu-so*).

FIGURE 70-4 (*Continued*)

MINISTRY OF AGRICULTURAL MACHINERY:
Institute of Agricultural Mechanization (*Nung-yeh Chi-hsieh-hua Yen-chiu-so*), Shanghai.

MINISTRY OF AQUATIC PRODUCTS:
Institute of Aquatic Products of the Yellow Sea (*Huang-hai Shui-Ch'an Yen-chiu-so*), Tsingtao.
Institute of Aquatic Products of the East China Sea.
Institute of Aquatic Products of the South China Sea.

MINISTRY OF BUILDING (*Chien-ch'u Kung-ch'eng Pu*).
Academy of Architectural Sciences.
Institute of Municipal Engineering.
Institute of Construction.
Institute of Building Materials.
Institute of Cement Research.
Institute of Glass Research.
Institute of Construction Machinery.

MINISTRY OF CHEMICAL INDUSTRY (*Hua-hsueh Kung-yeh Pu*):
Peiping Chemical Research Institute (*Pei-ching Hua-kung Yen-chiu-so*), Peiping.
Shen-yang Chemical Research Institute (*Shen-yang Hua-kung Yen-chiu-so*), Mukden.
Shanghai Chemical Research Institute (*Shang-hai Hua-kung Yen-chiu-so*), Shanghai.
Tientsin Chemical Research Institute (*T'ien-ching Hua-kung Yen-chiu-so*), Tientsin.
Shanghai Antibiotics Research Institute.
Shanghai Synthetic Drugs Research Institute.
Shanghai Pharmaceutical Research Institute.
Shanghai Biochemical Products Research Institute.
Chemical Machinery Research Institute.

MINISTRY OF COAL INDUSTRY (*Mei-t'an Kung-yeh Pu*):
Peiping Coal Mine Research Institute.
Tangshan Coal Mine Research Institute.
Fushun Coal Mine Research Institute.

MINISTRY OF COMMUNICATIONS (*Chiao-t'ung Pu*):
Water-borne Transport Research Department (No research facilities).

MINISTRY OF FOOD (*Liang-shih Pu*):
Organization for research not known.

MINISTRY OF FORESTRY (*Lin-yeh Pu*):
Academy of Forestry Research (*Lin-yeh K'o-hsueh Yen-chiu-yuan*).
Peiping Institute of Forestry (*Pei-ching Lin-yeh K'o-hsueh Yen-chiu-so*).
Inner Mongolia Institute of Forestry (*Nei-meng-ku Lin-yeh K'o-hsueh Yen-chiu-so*).
Nanking Institute of Forestry (*Nan-ching Lin-yeh K'o-hsueh Yen-chiu-so*).

MINISTRY OF GEOLOGY (*Ti-chih Pu*):
Academy of Geological Research (*Chung-kuo Ti-chih K'o-hsueh Yen-chiu-yuan*).
Institute of Geology (*Ti-chih Yen-chiu-so*), Peiping.
Institute of Geological Raw Materials.
Institute of Geophysical Prospecting (*Ti'ch'iu Wu-li T'an-k-uang Yen-chiu-so*).
Institute of Exploration Techniques (*K'an-t'an Chi-shu Yen-chiu-so*).
Institute of Hydro-geology and Engineering Geology (*Shui-wen-ti-chih Kung-ch'eng-ti-chih Yen-chiu-so*).
Institute of Geomechanics (*Ti-chih Li-hsueh Yen-chiu-so*).

MINISTRY OF LIGHT INDUSTRY (*Ch'ing Kung-yeh Pu*):
Institute of Pulp and Paper Research (*Chih-chiang Tsao-chih Yen-chiu-so*).
Institute of Rubber Research.
Institute of Salt Research.
Institute of Sugar Research.

MINISTRY OF METALLURGICAL INDUSTRY (*Yeh-chin Kung-yeh Pu*):
Institute of Iron and Steel Research.
Peiping Scientific Research Institute for Nonferrous Metals.
Institute of Mining Research.
Institute of Geological Research.
Anshan Iron and Steel Works Central Laboratory.
Fushun Steel Works Research Laboratory.

MINISTRY OF NATIONAL DEFENSE (See text for further information):
Academy of Military Sciences, People's Liberation Army (*Chung-Kuo Jen-min Chieh-fang-chun Chun-shih K'o-hsueh K'o-hsueh-yuan*).
PLA Academy of Medical Sciences (*Chung-kuo Jen-min Chieh-fang-chun I-hsueh K'o-hsueh-yuan*).
PLA Institute of Veterinary Sciences (*Chung-kuo Jen-min Chieh-fang-chun Chun-ma Wei-sheng K'o-hsueh Yen-chiu-so*).

MINISTRY OF PETROLEUM INDUSTRY (*Shih-yu Kung-yeh Pu*):
Institute of Petroleum Research.
Institute of Petroleum Geology Research.
Yumen Oilfield Research Laboratory.

MINISTRY OF POSTS AND TELECOMMUNICATIONS (*Yu-tien Pu*):
Peiping Posts and Telecommunications Research Institute (*Pei-ching Yu-tien Yen-chiu-yuan*).
Shanghai Posts and Telecommunications Research Institute (*Shanghai-hai Yu-tien Yen-chiu-yuan*).

MINISTRY OF PUBLIC HEALTH (*Wei-sheng Pu*):
Chinese Academy of Medical Sciences (*Chung-kuo I-hsueh K'o-hsueh-yuan*), Peiping.
Institute of Parasitology (*Chi-sheng-ch'ung-ping Yen-chiu-so*).
Institute of Epidemiology and Microbiology (*Liu-hsing-ping-hsueh Yu Wei-sheng-wu-hsueh Yen-chiu-so*), Peiping.
Institute of Labor Hygiene, Labor Protection and Occupational Diseases (*Lao-tung Wei-sheng Lao Tung Pao-hu Yu Chih-yeh-ping Yen-chiu-so*), Peiping.
Institute of Tuberculosis (*Chieh-ho-ping Yen-chiu-so*).
Institute of Dermatology and Venereology (*P'i-fu Hsing-ping Yen-chiu-so*).
Institute of Hypertension (*Kao-hsueh-ya Yen-chiu-so*).
Institute of Oncology (*Chung-liu Yen-chiu-so*), Peiping.
Institute of Blood Transfusion and Hemopathology (*Shu-hsueh Hsueh-i-ping-hsueh Yen-chiu-so*), Tientsin.
Institute of Antibiotics (*K'ang-chun-su Yen-chiu-so*).
Institute of Biologicals (*Sheng-wu Chih-p'in Yen-chiu-so*).
Institute of Medical Radiology (*Fang-she I-hsueh Yen-chiu-so*).

MINISTRY OF RAILWAYS (*T'ieh-tao Pu*):
Railway Scientific Research Institute.

MINISTRY OF STATE FARMS AND LAND RECLAMATION (*Nung-k'en Pu*):
South China Institute of Sub-tropical Crops.

MINISTRY OF TEXTILE INDUSTRY (*Fang-chih Kung-yeh Pu*):
Shanghai Textile Research Institute.
Peiping Cotton Fabric Printing and Dyeing Laboratory.

FIGURE 70–4 (*Continued*)

MINISTRY OF WATER CONSERVANCY AND ELECTRIC POWER (*Shui-li Tien-li Pu*): Water Conservancy Research Institute (or Academy). Nanking Water Conservancy Research Institute (*Nan-ching Shui-li K'o-hsueh Yen-chiu-so*). Cheng-chou Alluvium Research Institute (for Yellow River). Pang-fou Water Conservancy Research Institute (for Huai River). Hydroelectric Power Research Institute, Peiping. Thermal Power Research Institute.	RESEARCH INSTITUTE OF CHINESE TRADITIONAL MEDICINE (*Chung-i Yen-chiu-yuan*), Peiping, also known as the Academy of Chinese Traditional Medicine. Institute of Internal Medicine (*Nei-k'o Yen-chiu-so*). Institute of Surgery (*Wai-k'o Yen-chiu-so*). Institute of Acupuncture and Moxibustion (*Chen-chiu Yen-chiu-so*). Institute of Traditional Drugs (*Chung-yao Yen-chiu-so*), AMS.

NOTE Additional institutes newly formed in the years 1958–60 probably exist.

The organization and operation of research and development in the Ministry of National Defense (*Kuo Fang Pu*) are not known with any certainty except for medical research. Reportedly, the Chinese Communists have established an Academy of Military Sciences* (*Chung-kuo Jen-min Chieh-fang-chun K'o-hsueh-yuan;* or *Chung-shih K'o-hsueh-yuan*) to guide the army's study of military science, to utilize fully the latest scientific and technological developments, and to carry out planned research,** based on Soviet advances in military science, with the goal of accelerating the modernization of the Chinese Communist army. Some information suggests that the Academy of Military Sciences probably uses personnel and facilities of the Academy of Sciences, because the shortage of scientists in Communist China precludes the effective staffing of a completely integrated and independent research and development organization. The military services may exercise considerable authority in particular fields within the organization of the Chinese Academy of Sciences. It seems reasonable to suppose that the military would control and operate proving grounds and testing sites. A Mechanical and Electrical Institute under the control of the Ministry of National Defense has been reported, but it is not clear whether this institute is the same as the Institute of Electromechanics (*Chi-hsieh Tien-chi Yen-chiu-so*) of the Academy of Sciences, an institute with a similar name in the First Ministry of Machine Building, or a distinctly different institute under the Academy of Military Sciences.

C. RESEARCH UNDER PROVINCIAL GOVERNMENTS AND LOWER POLITICAL UNITS — Since 1958, the establishment of a large number of research organizations under local government auspices has been reported. Many of these facilities are part of local production units. These organizations are intended to serve the technical needs of local industry and agriculture and to promote the innovation of technical improvements. This increase in the number of research institutions parallels a vast increase in the number of universities and colleges. Both increases are part of the "great leap forward." Although neither is believed statistically fictitious, most of the new institutions, from the standpoint of quality, do not deserve the name university or research institute. These institutions represent the regime's so-called mass-line in education and research, a line which stresses that science, technology and learning is everybody's concern. The regime is eager to apply the benefits of research and development to production at all levels and to get all workers to think about how they can do "more and better work faster and more economically."

Local research and development activities are directed by the provincial governments aided by their local scientific and technical committees. In each province there is a branch of the Academy of Sciences headed by a local government or Party official. The academy branch organization was set up as part of the program for stimulating local scientific and technical activity and is believed to be more of a local than an academy operation. At present the provincial and other research and development organs are believed to be of little consequence to China's scientific and technological advancement.

3. Research at educational institutions

The Chinese Communists consider the personnel and facilities of the universities and colleges as important resources for research and development. They believe that research and development work in the universities and colleges not only aids industry, agriculture, and other technical areas, but is also an important factor in the teaching process, inasmuch as students as well as the faculty, are expected to participate in the research

* Other names seen in intelligence reports are the Military Science and Engineering Institute and the Military Engineering Institute. It is not known whether these are alternate names, subordinate organs, or institutes having no connection with the Academy of Military Science.

** There has been no confirmation of any actual scientific research conducted by this academy.

and development work. Graduating students are expected to prepare theses of some practical value.

In general, practical problems bearing on production are emphasized in the research and development effort. Many institutions have contracts with nearby industrial plants, whereby the plants get technical assistance from the colleges. It is believed that significant work is being done by the comprehensive universities and the more outstanding technical and polytechnical educational institutions. These universities and colleges undertake fairly significant problems of production, including relatively long-range problems involving fundamental theoretical considerations.

The basic organizational unit in the universities and colleges is the teaching and research group. Each department has several such groups which analyze, plan, organize, inspect, and evaluate both instruction and research work within particular fields of science or technology, such as theoretical physics, meteorology, nonferrous metallurgy, etc. It is believed that each university and college has a central research office for overseeing the research planning and operations. The Party committee of the university or college has ultimate control of all activities.

The number of universities and colleges is claimed by the Communists to have risen to 840 and in some reports to over 1,400, representing a 3 to 6 times increase in the years 1958–59. These new educational institutions have been set up under the auspices of local governments, communes, factories, mines, etc. Most of these institutions are universities and colleges in name only and will not represent a genuine increase in higher educational resources for a number of years. Known universities and colleges, where standards may actually approach higher educational levels of other countries, number around 260. Most of the comprehensive universities are of relatively high quality, particularly Peiping, Nankai, Fu-tan, Northeast People's, and Wu-han. Of the polytechnical universities, Tsinghua in Peiping is the most famous. Also noteworthy technical institutions are Chiao-t'ung, Tientsin, Harbin Industrial and Northwest Industrial Universities and Northeast Engineering College (sometimes called Shen-yang Engineering College) and Nanking Engineering College. The regime's intensive promotion of research and development everywhere and at all levels suggests that research and development work of some nature is conducted in all or nearly all higher educational institutions, although most is of low technical level. Significant work is probably being carried on, however, in the universities and colleges named above and in a few of the specialized technical colleges such as the Peiping Ferrous Metals College or the Peiping Petroleum Industry College.

No significant work is conducted by private and semiprivate research organizations. (FIGURE 70–5 is a glossary of Chinese Communist scientific and technical organizations.)

FIGURE 70–5. GLOSSARY OF CHINESE COMMUNIST SCIENTIFIC AND TECHNICAL ORGANIZATIONS

Academy of Architectural Sciences, Peiping.
Academy of Forestry Research (*Lin-yeh K'o-hsueh Yen-chiu-yuan*).
Academy of Geological Research (*Chung-kuo Ti-chih K'o-hsueh Yen-chiu-yuan*).
Academy of Military Sciences, People's Liberation Army (*Chung-kuo Jen-min Chieh-fang-chun Chun-shih K'o-hsueh K'o-hsueh-yuan*), PLA.
Anshan Iron and Steel Works (*An-shan Kang-t'ieh Kung-szu*) Central Laboratory, Anshan.
Central Institute of Meteorological Research (*Chung-yang Ch'i-hsiang Yen-chiu-so*), Peiping.
Chemical Machinery Research Institute (*Hua-kung Chi-hsieh Yen-chiu-so*), Peiping.
Cheng-chou Alluvium Research Institute (for Yellow River), Cheng-chou.
China University of Science and Technology (*Chung-kuo K'o-hsueh Chi-shu Ta-hsueh*).
China Scientific and Technological Information Institute (*Chung-kuo K'o-hsueh Chi-shu Ch'ing-pao Yen-chiu-so*).
Chinese Academy of Agricultural Sciences (*Chung-kuo Nung-yeh K'o-hsueh-yuan*), Peiping.
Chinese Academy of Medical Sciences (*Chung-kuo I-hsueh K'o-hsueh-yuan*), Peiping.
Chinese Academy of Sciences (*Chung-kuo K'o-hsueh-yuan*), AS, Peiping.
Chinese Institute of Scientific and Technological Information (*Chung-kuo K'o-hsueh Chi-hsu Ch'ing-pao Yen-chiu-so*).
First Ministry of Machine Building Industry (*Ti-i Chi-hsieh Kung-yeh Pu*).
Fushun Coal Mine Research Institute, Fushun.
Fushun Steel Works Research Laboratory, Fushun.
Hainan Island Malaria Research Station (*Hai-nan Tao-nueh-chi Yen-chiu-chan*), Hainan Island.
Hydroelectric Power Research Institute (*Shui-tien K'o-hsueh Yen-chiu-yuan*), Peiping.
Inner Mongolia Institute of Forestry (*Nei-meng-ku Lin-yeh K'o-hsueh Yen-chiu-so*).
Institute of Acupuncture and Moxibustion (*Chen-chiu Yen-chiu-so*).
Institute of Aeronautical Industry.
Institute of Agricultural Mechanization (*Nung-yeh Chi-hsieh-hua Yen-chiu-so*), Shanghai.
Institute of Agro-meteorology (*Nung-yeh Ch'i-hsiang Yen-chiu-so*).
Institute of Animal Husbandry (*Ch'u-mu Yen-chiu-so*).
Institute of Antibiotics (*K'ang-chun-su Yen-chiu-so*).
Institute of Aquatic Products of the East China Sea.
Institute of Aquatic Products of the South China Sea (*Yen-tung Sheng-yen-chou-nan-hai Shui-ch'an Yen-chiu-so*), Canton.
Institute of Aquatic Products of the Yellow Sea (*Huang-hai Shui-ch'an Yen-chiu-so*), Tsingtao.

FIGURE 70-5 (*Continued*)

Institute of Automobile and Tractor Research, Ch'ang-ch'un.
Institute for Battery Research.
Institute of Biologicals (*Sheng-wu Chih-p'in Yen-chiu-so*).
Institute of Blood Transfusion and Hemopathology (*Shu-hsueh Hsueh-i-ping-hsueh Yen-chiu-so*), Tientsin.
Institute of Building Materials, Peiping.
Institute of Cement Research (*Shui-ni Yen-chiu-so*), Peiping.
Institute of Chinese Traditional Veterinary Medicine (*Chung-shou-i Yen-chiu-so*).
Institute of Construction.
Institute of Construction Machinery.
Institute of Cotton (*Mien-hua Yen-chiu-so*).
Institute of Crop Breeding and Cultivation (*Tso-wu Yu-chung Tsai-p'ei Yen-chiu-so*).
Institute of Dermatology and Venereology (*P'i-fu Hsing-ping Yen-chiu-so*).
Institute for Electric Generators.
Institute of Electromechanics (*Chi-hsieh Tien-chi Yen-chiu-so*), AS.
Institute of Epidemiology and Microbiology (*Liu-hsing-ping-hsueh Yu Wei-sheng-wu-hsueh Yen-chiu-so*), Peiping.
Institute of Exploration Techniques (*K'an-t'an Chi-shu Yen-chiu-so*).
Institute of Gelogical Raw Materials, Peiping.
Institute of Geological Research.
Institute of Geology (*Ti-chih Yen-chiu-so*), Peiping.
Institute of Geomechanics (*Ti-chih Li-hsueh Yen-chiu-so*).
Institute of Geophysical Prospecting (*Ti'ch'iu Wu-li T'an-k-uang Yen-chiu-so*).
Institute of Glass and Ceramics Research, Peiping.
Institute for High Voltage Electrical Equipment.
Institute of Hydro-geology and Engineering Geology (*Shui-wen-ti-chih Kung-ch'eng-li-chih Yen-chiu-so*).
Institute of Hypertension (*Kao-hsueh-ya Yen-chiu-so*).
Institute of Industrial Engineering and Machine Building.
Institute of Internal Medicine (*Nei-k'o Yen-chiu-so*).
Institute of Iron and Steel Research (*Kang-t'ieh Kung-yeh Tsung-ho Yen-chiu-so*), Peiping.
Institute of Labor Hygiene, Labor Protection and Occupational Diseases (*Lao-tung Wei-sheng Lao Tung Pao-hu Yu Chih-yeh-ping Yen-chiu-so*), Peiping.
Institute of Machine Tools (*Kung-chu K'o-hsueh Yen-chiu-yuan*), Ch'ang-ch'un.
Institute of Materials Utilization Research.
Institute of Medical Radiology (*Fang-she I-hsueh Yen-chiu-so*).
Institute of Mining Research.
Institute of Municipal Engineering, Peiping.
Institute of Oncology (*Chung-liu Yen-chiu-so*), AS, Peiping.
Institute of Parasitology (*Chi-sheng-ch'ung-ping Yen-chiu-so*).
Institute of Petroleum Geology Research.
Institute of Petroleum Research (*Shih-yu K'o-hsueh Yen-chiu-so*), Peiping.
Institute of Plant Protection (*Chih-wu Pao-hu Yen-chiu-so*).
Institute for Power Traction Equipment.
Institute of Pulp and Paper Research (*Chih-chiang Tsao-chih Yen-chiu-so*).
Institute of Rubber Research (*Hsiang-chiao Kung-yeh Yen-chiu-so*), Tientsin.
Institute of Salt Research.
Institute of Sericulture (*Ts'an-yeh Yen-chiu-so*), Chen-chiang.
Institute of Shipbuilding Research.
Institute of Soils and Fertilizers (*T'u-yang Fei-liao Yen-chiu-so*).
Institute of Steam Turbines and Boilers.
Institute of Sugar Research.
Institute of Surgery (*Wai-k'o Yen-chiu-so*).
Institute of Traditional Drugs (*Chung-yao Yen-chiu-so*), AMS.
Institute for Transformers.
Institute of Tropical Electrical Equipment.
Institute of Tuberculosis (*Chieh-ho-ping Yen-chiu-so*).
Institute of Utilization of Atomic Energy (*Yuan-tzu-neng Li-yung Yen-chiu-so*).
Institute of Veterinary Medicine (*Shou-i Yen-chiu-so*).
Mechanical and Electrical Institute.
Ministry of Agriculture (*Nung-yeh Pu*).
Ministry of Agriculture's Chinese Academy of Agricultural Sciences (*Chung-kuo Nung-yeh K'o-hsueh-yuan*).
Ministry of Building (*Chien-ch'u Kung-ch'eng Pu*).
Ministry of Chemical Industry (*Hua-hsueh Kung-yeh Pu*).
Ministry of Coal Industry (*Mei-t'an Kung-yeh Pu*).
Ministry of Communications (*Chiao-t'ung Pu*).
Ministry of Education (*Chiao-yu Pu*).
Ministry of Food (*Liang-shih Pu*).
Ministry of Forestry (*Lin-yeh Pu*).
Ministry of Forestry's Chinese Academy of Forestry Research (*Chung-kuo Lin-yeh K'o-hsueh Yen-chiu-yuan*).
Ministry of Geology (*Ti-chih Pu*).
Ministry of Geology's Chinese Academy of Geological Research (*Chung-kuo Ti-chih K'o-hsueh Yen-chiu-yuan*).
Ministry of Light Industry (*Ch'ing Kung-yeh Pu*).
Ministry of Metallurgical Industry (*Yeh-chin Kung-yeh Pu*).
Ministry of National Defense (*Kuo-fang Pu*).
Ministry of Petroleum Industry (*Shih-yu Kung-yeh Pu*).
Ministry of Posts and Telecommunications (*Yu-tien Pu*).
Ministry of Public Health (*Wei-sheng Pu*).
Ministry of Public Health's Chinese Academy of Medical Sciences (*Chung-kuo I-hsueh K'o-hsueh-yuan*).
Ministry of Railways (*T'ieh-tao Pu*).
Ministry of State Farms and Land Reclamation (*Nung-k'en Pu*).
Ministry of Textile Industry (*Fang-chih Kung-yeh Pu*).
Ministry of Water Conservancy and Electric Power (*Shui-li Tien-li Pu*).
Nanking Institute of Forestry (*Nan-ching Lin-yeh K'o-hsueh Yen-chiu-so*).
Nanking Water Conservancy Research Institute (*Nan-ching Shui-li K'o-hsueh Yen-chiu-so*).
Pang-fou Water Conservancy Research Institute (*Pang-fou Shui-li K'o-hsueh Yen-chiu-so*), Pang-fou.
Peiping Chemical Research Institute (*Pei-ching Hua-kung Yen-chiu-so*), Peiping.
Peiping Coal Mine Research Institute.
Peiping Cotton Fabric Printing and Dyeing Laboratory.
Peiping Electrical Equipment Scientific Research Institute (*Pei-ching Tien-ch'i Kung-yeh Yen-chiu-so*), Peiping.
Peiping Ferrous Metals College.
Peiping Institute of Forestry (*Pei-ching Lin-yeh K'o-hsueh Yen-chiu-so*).
Peiping Posts and Telecommunications Research Institute (*Pei-ching Yu-tien Yen-chiu-yuan*), Peiping.
Peiping Scientific Research Institute for Nonferrous Metals, Peiping.
PLA Academy of Medical Sciences (*Chung-kuo Jen-min Chieh-fang-chun I-hsueh K'o-hsueh-yuan*).
PLA Institute of Veterinary Sciences (*Chung-kuo Jen-min Chieh-fang-chun Chun-ma Wei-sheng K'o-hsueh Yen-chiu-so*).
Railway Scientific Research Institute (*T'ieh-tao K'o-hsueh Yen-chiu-hsueh*), Peiping.
Research Institute of Chinese Traditional Medicine (*Chung-i Yen-chiu-yuan*), Peiping, also known as the Academy of Chinese Traditional Medicine.
Scientific Information Institute (*Chung-kuo K'o-hsueh-yuan K'o-hsueh Ch'ing-pao Yen-chiu-so*), now China Scientific and Technological Information Institute.
Scientific and Technological Association of the People's Republic of China (*Chung-hua Jen-min Kung-ho-kuo K'o-hsueh Chi-shu Hsieh-hui*).

FIGURE 70–5 (*Continued*)

Shanghai Antibiotics Research Institute (*Shang-hai K'ang-sheng-su Yen-chiu-so*), Shanghai.
Shanghai Biochemical Products Research Institute.
Shanghai Chemical Research Institute (*Shang-hai Hua-kung Yen-chiu-so*), Shanghai.
Shanghai Electric Cable Research Institute.
Shanghai Electrical Equipment Scientific Research Institute (*Hua-tung Tien-ch'i Kung-yeh Yen-chiu-so*), Shanghai.
Shanghai Pharmaceutical Research Institute (*Shang-hai Il-yao Kung-yeh Yen-chiu-so*), Shanghai.
Shanghai Posts and Telecommunications Research Institute (*Shang-hai Yu-tien Yen-chiu-yuan*), Shanghai.
Shanghai Scientific and Industrial Instrument Research Institute (*Shang-hai I-ch'i I-piao K'o-hsueh Yen-chiu-so*), Shanghai.
Shanghai Synthetic Drugs Research Institute.
Shanghai Textile Research Institute (*Fang-chih K'o-hsueh Yen-chiu-yuan*), Shanghai.
Shanghai University of Science and Technology (*Shang-hai K'o-hsueh Chi-shu Ta-hsueh*), Shanghai.
Shen-yang Chemical Research Institute (*Shen-yang Hua-kung Yen-chiu-so*), Mukden.
Sian Electric-Ceramic Research Institute.
South China Institute of Sub-tropical Crops (*Hua-nan Ya-je Ta-tso-wu K'o-hsueh Yen-chiu-so*), Hainan Island.
State Economic Commission (*Kuo-chia Ching-chi Wei-yuan-hui*).
State Planning Commission (*Kuo-chia Chi-hua Wei-yuan-hui*).
(State) Scientific and Technological Commission (*K'o-hsueh Chi-shui Wei-yuan-hui*).
Tangshan Coal Mine Research Institute.
Thermal Power Research Institute.
Tientsin Chemical Research Institute (*T'ien-ching Hua-kung Yen-chiu-so*), Tientsin.
Tsinghua University (*Ching-hua Ta-hsueh*), Peiping.
Water Conservancy Research Institute (*Shui-li K'o-hsueh Yen-chiu-yuan*), Peiping.
Yumen Oilfield Research Laboratory.

4. Exchange of information

The Chinese Communist regime in the last few years has vigorously promoted the wide collection, easy availability, rapid diffusion, and continuous review and use of new scientific and technological information. The practice of classifying much scientific and technical information as state secrets is believed to have hindered useful exchange of information to some degree. Nevertheless, the libraries, the services for translation and publication, and the general management of the storage and dissemination of scientific information are believed to be providing effective support to the Chinese Communist research and development effort. Most foreign scientific and engineering journals and significant books from both the Communist and Western worlds are believed to be available in Communist China.

Improvement of information work was one of the 57 explicit tasks set forth in the Twelve Year Plan for Science Development in 1956. In this connection, the Chinese Academy of Sciences set up that year a Scientific Information Institute (*Chung-kuo K'o-hsueh-yuan K'o-hsueh Ch'ing-pao Yen-chiu-so*); its purpose was to arrange exchanges with foreign organizations and to keep the Chinese Communist scientific community informed of world scientific developments. During 1958, further planning and reorganization of information work were evidenced by the State Council approval of a "Plan for the Development of Scientific and Technological Information Work." The plan had been submitted by the State Scientific and Technological Commission, the body charged with the overall responsibility for planning and supervising information work in the field of science and technology. The commission's work in this field is handled by its Scientific Information Division. Details of the Plan for the Development of Scientific and Technological Information Work have not been published, but the State Council action indicates a continuing concern for improving scientific information work. Probably, as part of the plan, was the announcement of the regime's intention to have every organization operate an information center engaged in gathering information in its field, supplying information useful for its planning work, keeping the organization informed of pertinent new domestic and foreign developments, and disseminating to other organs information about its own new developments. Another probable outcome of the plan during 1958 was the change of the name of the Academy's Scientific Information Institute to China Scientific and Technological Information Institute. The renamed institute may now be operating under or may be more closely controlled by the State Scientific and Technological Commission's Scientific Information Division.

The China Scientific and Technological Information Institute is not only the principal organ for collecting foreign scientific and technical information but also has the responsibility for keeping under continuous evaluation and reporting on the level and trend of domestic and foreign science and industrial technology.

The Library of the Academy of Sciences is the most significant library in the field of science and technology. In its central library in Peiping, the academy has some two million volumes. In the over 100 special libraries in the various research institutes, laboratories and branches are some four million additional volumes. In 1957, the Academy Library announced it was increasing its subscriptions to foreign language journals from 2,500 to 5,000 titles. The Communists report that the library exchanges publications with 804 organizations in 52 countries; presumably these exchanges are made mostly through the China Scientific and Technological Information Institute.

The general library service of Communist China centers in the National Library in Peiping. In addition to offering the usual library services, it is the national depository for a copy of all items published in Communist China. The National Library collects foreign journals and books through exchange arrangements made by its international exchange section; it also develops library management methods, aids libraries throughout China, trains library personnel, and directs the compilation of union catalogues. In 1958, its International Exchange Section had exchange arrangements with 1,800 organizations in 90 countries; of the 6,000 journals in the National Library over 2,000 had been obtained through exchanges and of those 30% had come from the Soviet Union. The National Library has some six million volumes. Other especially large general libraries in Communist China are those in Nanking and Shanghai.

The libraries of the universities and colleges are another important resource for scientific and technical literature; they number about 230. The comprehensive universities have the better general libraries and of those, the library of Peiping University is the most outstanding. It is an old and well-established library with some two million volumes. Collections of engineering literature are probably better at Tsinghua University and other polytechnical universities and specialized engineering colleges.

The division of responsibility in exchange work between the China Scientific and Technological Information Institute and the National Library is not clear except that the National Library operates in all fields. Another apparent distinction is that the China Scientific and Technological Information Institute extends its work into the collection of commercial catalogues, brochures and various serials of industrial concerns. Probably exchanges are arranged by any organization that has an obvious common interest with a foreign organization. Individual scientists also have been pressed into cultivating exchanges with scientific acquaintances abroad.

The general acquisition and coordination of subscriptions to foreign journals are under the general direction of the Central Council of Library Affairs set up in 1957 under the National Library; the council was composed of representatives of 10 major libraries. This council is also the central body for initiating and generally overseeing the compilation of union catalogues, book lists and indices in major libraries throughout the country. In the scientific and technical field alone the Scientific Information Division of the (State) Scientific and Technological Commission is believed to be the central policy and supervisory organ and probably would have a prominent voice in the Central Council for Library Affairs.

The overall policymaking and coordination in scientific and technological publication work is believed to be the responsibility of the Scientific Information Division of the (State) Scientific and Technological Commission. Publication of scientific and technological books and periodicals is carried out by the Academy of Sciences' Science Press (*K'o-hsueh Chu-pan-she*) and by the publication organs of the various ministries and other technical organs of the State Council. During 1960, the name of the Science Press may have changed to the State Scientific and Technological Press (*Kuo-chia K'o-hsueh Chi-shu Chu-pan-she*). Such a change may reflect a switch away from full academy control to closer control or operation by the (State) Scientific and Technological Commission.

The academy's publications cover the usual scientific and professional engineering areas. Literature published by the ministries supports their industrial or technical responsibilities. The academy's Publication and Translation Committee has general responsibility for academy publication work. Operations are carried out by the academy's Publication and Translation Bureau, the Science Press being under this bureau.

Professional journals are edited by the various scientific and engineering societies, institutes of the academy, and higher educational institutions. A number of Chinese journals have abstracts or tables of contents in foreign languages. The *Chinese Medical Journal* has an edition published in English. The *Science Record* and *Scientia Sinica,* academy journals for original papers in any scientific field, are written in English or other foreign languages. The academy's general news journal, the Chinese language semimonthly *K'o-hsueh T'ung-pao,* has tables of contents in both English and Russian; the title *Scientia* is carried at the head of its English table of contents.

Scientific and engineering societies have been organized in all general fields and in many specialized areas. The affairs of societies are in the hands of boards of directors and standing committees. The Chinese Chemical Society, which may be typical, has a board of 48 persons meeting once a year and a standing committee of 12 meeting quarterly. The standing committee is the effective executive body and elects its chairman and other officers. The societies edit journals and hold local and national meetings, conferences, symposia, and so forth. An important role of societies in Communist China is to provide a communication channel for the control of the specialized personnel in various scientific and technical fields.

All scientific and engineering societies are subordinate to the Scientific and Technological Association of the People's Republic of China. This association is the mass control organization for scientific and technical personnel. The association was founded in 1958 by amalgamating the All-China Federation of Scientific Societies and the All-China Association for the Popularization of Science and Technology. The amalgamation involved no new duties but reflected the regime's attempt to strengthen the connection between the work of scientists and engineers and the technical innovation program among workers; both groups are considered by the regime to have the common objective of contributing to the regime's program for a vast technological revolution.

The Soviet Union and other bloc countries have provided much scientific and technical literature, particularly concerning engineering and industry. Thousands of works have been translated and published in Chinese. Soviet journals are regularly available in China. The Soviet All-Union Institute of Scientific and Technical Information (VINITI) has been sending various periodicals to Communist China. Interlibrary loan arrangements are claimed to be in effect with important libraries in the Soviet Union.

Exchange of information, joint research operations, and aid to Chinese research and development have been expanded since a 5-year Scientific Cooperation Agreement was signed 18 January 1958 between Communist China and the Soviet Union. Similar agreements are in effect between China and other bloc countries. Many Chinese researchers have visited the Soviet Union and, to a lesser extent, the Satellite countries to confer, to inspect research underway, and to exchange information.

Since about 1955, the Chinese Communists have participated in a few international scientific conferences. Their participation has not yet been extensive and does not appear to be increasing. Although the Chinese Communist regime recognizes the value of maintaining international scientific contacts, political considerations have restricted the growth of international scientific associations. One of the main political problems for the Chinese Communists is the presence or possible attendance of representatives of the Republic of China. As an example, the Communists formally withdrew in January 1960 from the International Astronomical Union (IAU), when the union admitted as an adhering body the Astronomical Society of the Republic of China.

The Communists are presently members of the International Unions of Biochemistry and of Physiology, the Division of History of Science of the International Union of History and Philosophy of Science, and have been accepted in the International Union of Pure and Applied Physics. Inasmuch as Nationalist China was also admitted to the latter, the Chinese Communists may be expected to withdraw. Besides participating in these few organizations under the International Council of Scientific Unions (ICSU), the Communists have participated in a few international conferences and symposia called by other bodies, particularly those held in bloc countries. Scientific relations with Japan started in 1955 and appeared to be increasing up to 1958, when contacts practically ceased. There are some indications that scientific contacts with Japan may resume. On the whole, international scientific contacts have not been extensive with any nonbloc country.

C. Financing of scientific and technical activities

Starting with 1956, the regime's financial support for research and development and the training of scientists is believed to have been running at a rate close to the amount that could be absorbed effectively. Budget figures for these purposes are too scarce to permit anything more than the most general observations. The view that support is adequate is based largely on the fact that lack of funds is not mentioned either by the Communists or by foreign observers as a hindrance to science development. In addition, it is known that appropriations for research and development went up sharply in 1956 and by 1960 had risen fourfold over 1956. The 1960 budget plan for science was 1.55% of the total national budget, a proportion considered relatively high in view of the shortage of competent researchers. Appropriations for research and development and the appropriation's percentage of the total national budget are given in the following tabulation:

	APPROPRIATION IN MILLIONS OF YUAN	PERCENTAGE OF TOTAL BUDGET
1951	7.87	*.066*
1952	11.3	*.068*
1953	31.9	*.15*
1954	33.9	*.14*
1955	93.0	*.34*
1956	235.0	*.77*
1957	293.0	*1.0*
1958	384.0	*.94*
1959	820.0	*1.60*
1960	1,081.0	*1.55*

The amounts shown include funds for construction and equipment, as well as the usual operating expenses such as wages, travel, library material, maintenance, etc. The research and development appropriations cover the expenses of the Academy of Sciences, the research and development organs of the various ministries and State Council technical bureaus, and unknown scientific and technical activities of a third group called "cultural, educational, and sanitation units." The content or purpose of the third group is not known, but the more significant unknown is whether the research and development activities of universities and colleges are budgeted under the "Science" category of the Chinese Communist national budget, the category herein referred to as the research and development appropriation. The cost of research and development in the universities and colleges is believed to be relatively small compared to all other research and development activities. Fragmentary budget figures for university and college research work put the amount at 6 million yuan for 1956 and 10 million yuan for 1957.

Appropriations chargeable to the training of scientists are not known and adequate budget figures on higher education are not available. For 1956 through 1958, published figures put the budget for higher education at about 600 million yuan for each year. For comparison, the 1958 science budget was 384 million yuan. Much significant training of research personnel is carried out by the Academy of Sciences and it is probable that much of the expense involved is chargeable to the academy's allotment from the "Science" appropriation.

D. Scientific and technical manpower

Communist China's manpower resources for science and technology include a small nucleus of competent Western-trained scientists now being augmented by relatively well-trained personnel returning from study in Soviet bloc countries, particularly from the Soviet Union. Other personnel graduated from Chinese universities and colleges are not well trained by comparison. The number of competent scientists available is sufficient to provide a sprinkling of leaders throughout a greatly expanded establishment covering nearly all scientific and technological fields. Satisfactory programs for training new scientists have been slow in getting underway and few competent new scientists have been trained in China since the Communists assumed control of the government.

1. Scientific and technical education

Of the more than 600,000 college graduates in Communist China at the end of 1959, about one-half had been trained in scientific and technical fields as shown in the following tabulation:

Natural sciences	38,000
Engineering	175,000
Health	50,000
Agriculture and forestry	40,000
Total	303,000

The quality of Chinese education has not been high. Many students through 1954 were graduated after only two or three years of training. The fields of specialization in many cases have been so narrow that graduates have had very spotty knowledge of scientific and engineering principles. The quality of the teaching force has also been relatively low, as the large majority has been young and inexperienced. A large proportion of the student's time has been taken up with political lectures and discussions and with practical work in factories and on farms. All these conditions have tended to reduce educational standards, but large numbers of narrowly trained students provide valuable manpower resources in China's current stage of development. Up to 1960, training in the Soviet Union and other bloc countries has been the most important source of well-trained new personnel under the Communist regime.

Within Communist China the training of new scientists is carried out by the universities and colleges and by the Academy of Sciences. The comprehensive universities, which are similar to the faculties of arts and sciences of Western universities, have the particular function of training research personnel and teachers for higher educational institutions. The Academy of Sciences' China University of Science and Technology was established specifically to provide undergraduate training for personnel who are to be trained for further research work. The polytechnical and specialized engineering institutions train students primarily for industrial and engineering work, but these institutions conduct research work, and some of their graduates are assigned to research and development establishments. The agriculture and forestry colleges and the medical colleges also supply some research personnel.

All education comes under the general direction of the Ministry of Education, and the ministry operates the comprehensive universities and some industrial and engineering institutions. Specialized technical colleges are believed to be controlled largely by the corresponding technical ministries. Since 1958, there has been a vast expansion in the number of institutions called "universities" and "colleges," with as many as 1,400 being reported in existence. Most of the new education institutions have been set up under the auspices of local governments, communes, factories, mines, etc., and represent the regime's effort to spread scientific and technical knowledge and promote workers' interest in making technical innovations. The level of education in these many so-called universities varies widely, but, in general, their standards cannot be considered of higher educational level. Known universities and colleges, where standards may actually approach a higher educational level, number around 260 and consist of the following types: 20 comprehensive universities; 72 polytechnical and technical; 35 agriculture and forestry; 40 medicine, public health, pharmacy; 57 teachers; and 36 others.

The departments of comprehensive universities include the basic academic fields such as mathematics, physics, chemistry, and biology. Some, but not all, of the comprehensive universities, train students in astronomy, meteorology, geology, and geophysics. By 1960, most of the comprehensive universities were probably reaching academic standards compatible with the needs of Communist China's research and development establishment but, previously, their graduates were, in general, poorly grounded in the fundamentals of scientific subjects and ill-prepared to go on to graduate study and research work. Leading comprehensive universities include Peiping, Nankai, Fu-tan, Northeast Peoples', and Wu-han.

Among the technical institutions Tsinghua University (*Ching-hua Ta-hsueh*), Peiping, is the most famous. Also noteworthy among the polytechnical institutions are Chiao-t'ung, Tientsin, Harbin Industrial and Northwest Industrial universities, and Northeast Engineering College (sometimes called Shen-yang Engineering College) and Nanking Engineering College. (Chiao-t'ung University is sometimes referred to by its translated name "Communications University.") There are specialized technical colleges in most fields; examples are the Peiping Iron and Steel College, Peiping Aeronautical College, Peiping Post and Telecommunications College, Peiping Petroleum College, East China Textile Engineering College, T'ung-chi University (civil engineering), Shantung Oceanography College, and Peiping Agricultural University.

The Academy of Sciences, since its formation in November 1949, has had as a major duty the training of new scientists. Efforts to carry out this duty have not been appreciably fruitful because the academy scientists capable of training advanced level researchers were occupied, not only with a multiplicity of research and technical tasks, but also with many administrative and organizational duties. Another handicap was the dearth of university and college graduates who were adequately prepared for graduate study. Not until 1958 did the academy commence a training program that had some promise of providing a regular supply of new and competent researchers.

In the summer of 1958, the academy set up the China University of Science and Technology, which has 13 departments. The teaching staff was to be drawn from the scientists of the academy and the students, carefully selected, were expected to be associated in the course of their studies with actual research activities in academy research institutes. The initial enrollment in the fall of 1958 was 1,600. The announced areas of study in the new university suggest the possibility that the university may have been set up particularly to train students for work in the nuclear energy field, but no further indication of such specialization has appeared.

Formal and informal training at all levels, including graduate level, may be expected to be found at all institutes of the academy. The China University of Science and Technology, however, is the only academy university or college whose existence is well established as a formal higher educational institution. A Shanghai University of Science and Technology was reported to have been set up in 1958 but its existence is unconfirmed; 300 were said to have been enrolled in 1959. Eight colleges also have been mentioned, but also unconfirmed, as having been established in research institutes of the academy.

Selection of students for higher education is based on examinations for academic achievement, physical condition, and understanding of Communist politics. Normally students matriculate from upper middle school, but college students may be chosen from among those in the working force, including those who may not have completed formal secondary education. Higher education is not free, but provisions are made to aid those needing it and it is believed that no promising student is permitted to drop out for financial reasons.

No academic degree system is currently in operation in Communist China. College graduates receive a certificate attesting to the studies completed. In 1955 and 1956, there was a plan under consideration whereby those completing the four-year postgraduate training program then being initiated would receive the degree of "Associate Doctor." This plan to award degrees, however, was criticized, both from the academic aspect of the difficulty under current conditions in China to adopt and enforce academic standards for the degree, and also from the political standpoint that the degrees were "undemocratic." The plan to award degrees was not adopted.

Training of new researchers at the graduate level has lagged, and the number in training has been limited by a shortage of qualified candidates and competent instructors. Before 1956, the universities and colleges had two-year graduate programs designed primarily for training teachers for higher educational institutions. The Academy of Sciences has had a training program since 1950, but the program is believed to have had little significant educational value in its early years.

Four-year programs designed to train new scientists commenced in the Academy of Sciences in 1955 and in the universities and colleges in 1956. Difficulties apparently arose and, in 1957, the academy abandoned its announced enrollment plan except for seven persons admitted for training in electronics. Formal enrollment in the universities and colleges also may have been abandoned, as no enrollment in subsequent years in either the academy or the universities and colleges has been mentioned in Chinese Communist literature. Graduate training undoubtedly continues, but expansion appears to be slow and may not be noticeable until larger numbers of the better trained graduates of the China University of Science and Technology and other universities with improved standards begin to become available for graduate training.

Graduate training in the Soviet Union and other bloc countries will continue to be more significant than training in China for the expansion of the research force, at least for the first few years of the 1960's. All, or nearly all, students sent abroad in the fall of 1957 and thereafter have been graduate students. Before that time, most were undergraduate students, and these numbered some 2,000 a year or more in 1955 and 1956. After 1956, the rate is believed to have dropped to one or two hundred per year in 1957 and 1958 and then to have risen to about 500 per year in 1959.

Students returning to China through 1959 amounted to some 2,500, of whom some 700 are estimated to have reached *kandidat* level (roughly equivalent to the U.S. Ph.D.). From the satellites, possibly some 600 have returned, of whom possibly 100 have had graduate training. Nearly all of the returnees are believed to have studied scientific or technological subjects. During the 1959–60 academic year, there were 4,600 Chinese studying in the Soviet Union, of whom over 1,400 were training at the graduate level. The number studying in the satellites in the 1959–60 year is probably about 600, of whom possibly 300 are graduate students:

	U.S.S.R.		SATELLITES (ESTIMATIVE)	
	Total	Graduate Students	Total	Graduate Students
Sent through 1959	7,100	2,100	1,200	400
Returned through 1959	2,500	700	600	100
Studying abroad, 1959–60	4,600	1,400	600	300

Returnees from the Soviet Union constitute nearly all the capable scientists currently being added to China's scientific manpower resources. *Kandidat*-level trainees should be returning at a rate of several hundred per year for the next few years. Only a few new scientists are believed to have been trained completely in China. Graduate training in China cannot be evaluated precisely quantitatively or qualitatively; however, it is probable that China-trained, new scientists with reasonably good capabilities will not be added at a rate much over a few hundred per year in the early years of the 1960's.

2. Manpower for research and development

Of the over 300,000 college graduates in Communist China, as many as 30,000 are believed to be employed by research and development organizations including personnel engaging in research in the universities and colleges. This number does not include physicians in clinical and public health work nor engineers in industry, where their duties call for some engineering development work such as adapting foreign designs to Chinese production conditions. Of the 30,000, some 7,000 are reported to be employed by the Academy of Sciences, an estimated 13,000 are employed in ministerial research organs, and 10,000 are estimated to be devoting some time to research in the higher educational institutions.

The quality of the 30,000 varies widely; about 600 hold doctorate degrees from Western universities and possibly 800 are newly returned Soviet bloc *kandidat* degree holders. Some of these advanced degree holders and some other well-trained and experienced personnel constitute China's scientific leaders—those who are capable of planning, supervising, and carrying out research of a quality that could be of interest to scientists in advanced countries. The number of such personnel is estimated to be about 1,000. Of the remaining 29,000, possibly 7,000 could generously be called research scientists; the other 22,000 may be better described as research assistants, trainees or technicians.

3. Social and economic position of scientists and engineers

In Communist China, scientists and engineers generally have a favored social and economic status. The intellectuals, particularly the scientists and engineers, have been referred to by the regime as a "treasure of the state." Most of the better scientists and engineers, however, have been educated, or have had some work experience, in Western countries—causing the regime concern about their political reliability. Treatment of scientists and engineers has probably varied, depending on how acutely their services have been needed and how amenable they have been to ideological indoctrination. A few are known to have been removed from positions of influence in recent years, and in the early days of the Communist era some may have been eliminated. Many scientists, especially those educated in foreign countries, certainly have undergone considerable mental torment, but it is believed that most have adjusted to the new conditions of life and work under the Communist regime. Most of the scientists are believed to be living far better than average Chinese and under no more threat than is usually expected under a totalitarian regime.

Monthly wages of researchers and associate researchers and the equivalent grades of professor and associate professor in the universities and colleges range from 120 to 400 yuan per month. Assistant researchers and assistants, and equivalent grades in the education system, receive from 50 to 120 yuan per month. The average pay of workers on fixed wages or salaries is believed to be about 50 yuan per month. In addition to monthly wages, the scientists and engineers may receive free quarters or nominal rent and various allowances; there is no income tax. There is also opportunity for additional income from the publication of papers or from translation work.

A system of prizes and awards for scientists was adopted in 1955. The Academy of Sciences is the awarding body. Outstanding work is rewarded by medals, certificates, or monetary awards up to 10,000 yuan. These honors are to be awarded every four years, the first having been given in January 1957.

E. Comments on principal sources

Chinese Communist publications constitute the major source of information. Some valuable data and evaluations are provided by U.S. reports based on information obtained from defectors and Western travelers in China. Of particular value are the translations of the Joint Publications Research Service. The translation services of the U.S. Consulate General in Hong Kong have also been of value. Among the Chinese Communist journals of particular value in the preparation of SECTION 70 is *K'o-hsueh T'ung-pao,* the Chinese Academy of Sciences' general journal of scientific reports and news of activities in the scientific community. Articles in Soviet journals occasionally provide new information, particularly reports of the experiences of Soviet scientists in China.

Information in general is inadequate. The methods of operating and the success of the research programs are not clearly discernible. Information about the organization and operation of research organizations under the ministries is especially meager, with only a dearth of material available on the Ministry of National Defense. The information available is believed to provide a reasonably accurate sketch of Communist China's scientific resources, plans, and general operations, but some evaluations must be considered tentative at the present time.

71. Electronics

A. General

1. Capabilities and trends

From the beginning of the Chinese Communist regime in October 1949, major emphasis has been placed on applied rather than on fundamental research. Chinese leaders have stressed repeatedly the paramount importance of placing science and technology at the service of production and of repudiating "science for science's sake." This stress on production is applied not only to research and development facilities connected with industrial units, but also to the Academy of Sciences and educational facilities. As a result, comparatively little fundamental electronics research has been conducted and major attention has been given to engineering development leading to known and proven goals. Almost all such development work has been concerned with adapting Soviet bloc and Western electronics devices and equipment to the manufacturing conditions of China—a process requiring a high degree of ability on the part of a very considerable number of Chinese engineers.

At present there is an increasing tendency to permit more research and development having long-range goals. To cope with the new situation, additions have been made to the present Twelve Year Prospective Plan for Scientific and Technological Development. The Three Year Program for Research on Pure Natural Science presumably included material concerned with electronics.

There appears to be no system of priorities in Chinese development of the electronics components, materials, and apparatus required for military purposes and for important civilian uses such as telecommunications and broadcasting. The Chinese are attempting to achieve self-sufficiency in the production of such items by giving equal and simultaneous emphasis to all fields of electronics. The Chinese now plan to surpass the U.K.'s level of production by the end of the twelve-year plan in 1968. Development of electronics items is based almost invariably on Soviet or Western prototypes.

The Chinese are becoming more sophisticated in their attacks on electronics problems and are in fact rapidly becoming self-sufficient in a wide variety of electronics fields. At present the Chinese are believed to be almost completely self-sufficient in vacuum tubes (excluding special-purpose tubes such as magnetrons and klystrons); components such as capacitors and resistors; and broadcast-type radio and television receivers and transmitters. Transistors and semiconductor devices are rapidly becoming available. Production of consumer-type electronics items such as radio and television receivers is restricted to a number just sufficient to meet the government's needs for propaganda outlets and for "prestige" goods, principally for export.

The total Chinese Communist electronics capability is inferior in quality and quantity to that of Japan but is much greater than any other Asian country. With the exception of about a dozen larger units such as the Peiping Electron Tube Plant (*Pei-ching Tien-tzu-kuan Ch'ang*), Peiping, and the Institute of Electronics (*Tien-tzu-hsueh Yan-chiu-so*), Peiping, of the Chinese Academy of Sciences (*Chung-kuo K'o-hsueh-yuan*), AS, Peiping, Chinese electronics facilities concerned with some phase of engineering or other electronics development probably employ a maximum of 50–75 people at any one organization. In mid-March 1960, the number of Chinese electronics facilities—plants, institutions, and laboratories—conducting at least some engineering or other development was approximately 325–350 units. A maximum of perhaps 5,000 men are employed on electronics development. (FIGURE 71-1 shows the locations of electronics research and development activities in Communist China.)

2. Background and organization

a. HISTORY — In October 1949 the Chinese electronics industry was very small and consisted largely of units where foreign-made components were assembled. Between 1949 and 1952 the Communist's principal aim was to repair and restore electronics production capacity and to achieve economic stability. In addition, some very early attempts were made to construct new research, development, and production facilities. On 1 September 1949, for example, the Chinese set up a three-man electron tube research unit at the prewar Nanking Light Bulb Plant, a plant now known as the East China Electron Tube Plant (*Hua-tung Tien-tzu-kuan Ch'ang*), Nanking. On the same day, construction started on the Nanking Electron Tube Plant (*Nan-ching Tien-tzu-kuan Ch'ang*), Nanking, and within a year this plant

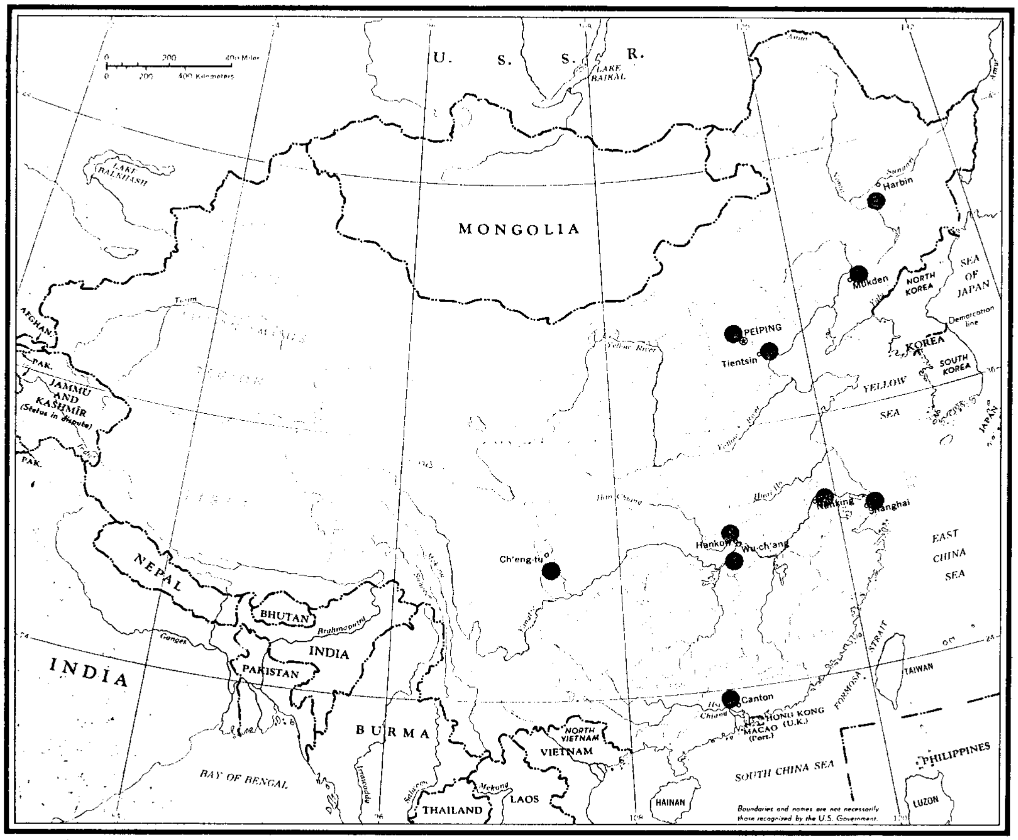


FIGURE 71–1. LOCATIONS OF ELECTRONICS RESEARCH AND DEVELOPMENT ACTIVITIES

LOCATION—SIGNIFICANCE

CANTON (23°07′N., 113°15′E.)—Ch'ang-ch'un Telephone Equipment Plant.

CH'ENG-TU (30°40′N., 104°04′E.—Ch'eng-tu Posts and Telecommunications Engineering College; Southwest Radio Equipment and Materials Plant.

HANKOW (30°35′N., 114°16′E.)—Wu-han Geophysical Observatory.

HARBIN (45°45′N., 126°39′E.)—Harbin (Polytechnical) Engineering College.

MUKDEN (41°48′N., 123°27′E.)—Northeast (Polytechnic) Engineering College.

NANKING (32°03′N., 118°47′E.)—East China Electron Tube Plant; Nanking Electron Tube Plant; Nanking Engineering College; Nanking Radio Plant; Radar Institute.

PEIPING (39°56′N., 116°24′E.)—Chinese Academy of Sciences; Institute of Automation and Remote Control; Institute of Computation Techniques; Institute of Electronics; Institute of Mathematics; Institute of Physics; I-pin Radio Equipment and Materials Plant; North China Radio Equipment and Materials Plant; Peiping Broadcasting Equipment and Materials Plant; Peiping Electron Tube Plant; Peiping Long-Distance Telecommunications Bureau; Peiping Posts and Telecommunications College; Peiping Telecommunications Equipment Plant; Peiping University; Posts and Telecommunications Peiping Equipment and Materials Plant; Posts and Telecommunications Scientific Research Institute; Tsing-hua University.

SHANGHAI (31°14′N., 121°28′E.)—Institute of Radio Techniques; Posts and Telecommunications Shanghai Equipment and Materials Plant; San-ying Electrical Industry Plant; Shanghai Light Bulb Plant; Shanghai Radio Plant; Shanghai Solar Energy Equipment Manufacturing Plant; Shanghai Telecommunications Research Institute; Tien-t'ung Vacuum Tube Experimental Plant.

TIENTSIN (39°08′N., 117°12′E.)—Tientsin Radio Plant.

WU-CH'ANG (30°32′N., 114°18′E.)—Institute of Geodesy and Cartography.

began to produce copies of a considerable number of U.S. vacuum tubes. Early attempts also were made to utilize native raw materials, such as tungsten reserves. In late 1953, the Shanghai Light Bulb Plant (*Shang-hai Teng-p'ao Ch'ang*) (the prewar General Electric Light Bulb Plant) completed three years of experiments on the production of tungsten wire. The first batch of electric bulbs with Chinese-made filaments were manufactured in early 1954, and in January 1955, large-scale production of tungsten wire was begun. In May 1954 the plant also produced molybdenum filaments for light bulbs.

Volume production of electronics devices and equipment did not begin until 1956–57, when a number of large electronics facilities built with Soviet bloc assistance were placed in operation. During erection of one of these facilities, the Peiping Electron Tube Plant, the Soviets assisted the Chinese in surveying the site, constructing the buildings, and installing the very latest type of Soviet-built equipment. Another example of bloc assistance is the North China Radio Equipment and Materials Plant (*Hua-pei Wu-hsien-tien-tzu Ch'i-ts'ai Ch'ang*), Peiping, for which the East Germans furnished more than 90% of the materiel. Altogether 230 East German specialists went to China in connection with the plant and 70 Chinese were sent to East Germany for periods ranging from 6 to 18 months. The effect on Chinese electronics of the reported withdrawal of bloc technicians from China cannot be determined at this time.

b. ORGANIZATION — The organization of Chinese electronics facilities—plants, institutions, laboratories—concerned with fundamental and applied electronics research and development was being socialized very gradually until early 1955. In mid-1955, Mao Tse-tung called for a rapid speedup of socialization and collectivization and, by the end of 1956, over 90% of the electronics and other industries not previously state-owned had been organized into state-controlled "joint state-private" enterprises. Within a year private business had been largely eliminated, and by 1960 only a very small number of privately owned units concerned with electronics were still in existence.

In recent years control over all kinds of electronics facilities has been decentralized to a very considerable degree. By June 1958, responsibility for some 80% of the total number of facilities under the central industrial ministries had been shifted to the local governments; however, large industrial units such as the Peiping Electron Tube Plant, and most defense-industry and other "special" facilities almost certainly were not transferred. Decentralization also has taken place in educational institutions concerned with electronics.

During the last four or five years facilities of the Academy of Sciences have conducted a considerable amount of electronics research, most of it directed toward the immediate needs of production. The most important of the academy institutions in this field is the Institute of Electronics at Peiping. Another important unit of the academy is the Institute of Physics (*Wu-li Yen-chiu-so*), Peiping, formerly the Institute of Applied Physics. Much fairly fundamental work on semiconductor devices and transistors is conducted at this institute, as well as serial production of transistors.

Other electronics research is conducted at educational institutions and at various facilities subordinate to the Ministry of Posts and Telecommunications (*Yu-tien Pu*). Most of the work at these institutions is directed towards the immediate needs of production.

Five categories of organizations now comprise China's electronics industry:

Facilities (now very few) owned and operated by private individuals.
Facilities jointly operated by private individuals and by the central or local governments.
Facilities subordinate to provincial and county governments.
Facilities subordinate to ministries and other segments of the central government.
Facilities subordinate to the Chinese Academy of Sciences and its branches.

There is no division of responsibility for fundamental and applied research among these categories. Further, within each category, institutions primarily responsible for research activities are doing some production, and production organizations are conducting research. For example, an Academy of Sciences institute and a number of educational units are manufacturing transistors in fairly large quantities. On the other hand, a considerable number of manufacturing facilities have developed and produced devices using transistor and semiconductor techniques. See FIGURE 71–2 for the organization of major Chinese Communist electronics research and development facilities.

c. PLANNING — Broad policy decisions concerned with electronics and other scientific fields are made at the highest level of the Communist Party. Party leadership is manifested not only

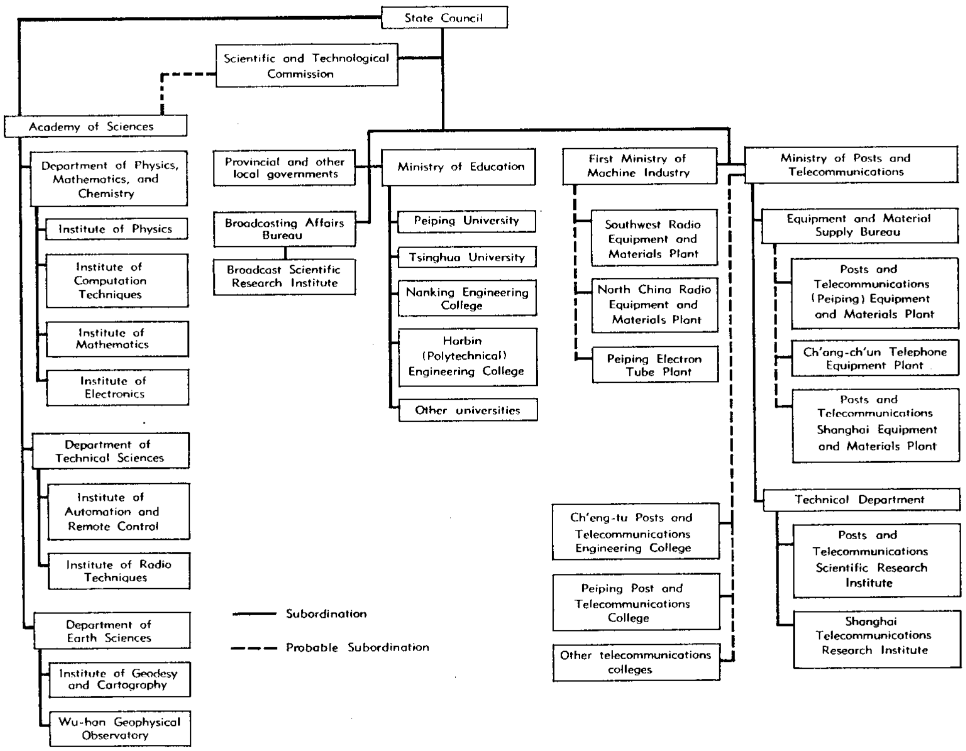


FIGURE 71–2. TENTATIVE ORGANIZATION OF CHINESE COMMUNIST ELECTRONICS RESEARCH AND DEVELOPMENT FACILITIES

in formulation of policy, but control is exercised down to the individual research institutions by Party members who frequently have little or no scientific or technical background.

The State Scientific and Technological Commission, formed in November 1958 from an amalgamation of the State Technological Commission and the Scientific Planning Commission, is the main supervisory and coordinating organ of Chinese scientific and technological research; it is directly subordinate to the State Council. Among other departments, the former Scientific Planning Commission reportedly contained a Department of Radio and Telecommunications and a Department of Electronics. In order to implement the "policy of combat readiness in the military sciences," the departments were "to supervise and investigate their respective scientific research organizations." Similar departments are probably found in the new Scientific and Technological Commission.

In mid-1957 the former Scientific Planning Committee prepared the final draft of a twelve-year plan for scientific development. According to Chou En-lai, the aim of the plan was to raise China's scientific level, so that by 1967 China would approach "the world's most advanced levels" in certain "vital departments." Altogether the plan covered 57 aspects of research, consolidated into 12 categories. The second of these was described as "new electronics techniques (including semiconductor electronics, computing machines, and super-high-frequency studies)." In March 1958 the committee approved the

Chinese scientific and technical program for 1958, covering over 3,000 subjects. Electronics items included:

Research into semiconductors, "including the manufacture of germanium elements."
Research into ultrahigh-frequency techniques, carrier systems of telecommunications and associated equipment.
Construction of the Soviet M-3-type computer and the beginning of construction of the Soviet "BESM" electronic computer.

It is believed that persons now responsible for refinement of the twelve-year plan and the development of supporting yearly plans are less important figures than those who took part at the beginning. By 1959, fewer Central Committee members appeared to be taking direct supervisory roles in the scientific and technological areas. However, further important national decisions on such items as electronics almost certainly will be made at the top level of the Party, although the Scientific and Technological Commission can and will offer advice and originate policy recommendations. For further information on important Chinese organizations controlling and planning scientific research, see SECTION 70 of this NIS.

B. Major research and development by field

1. Radio and television communications

a. BROADCAST-TYPE RADIO — The Chinese radio industry, although small-scale when compared with that of the West, is scattered over the country in Peiping, Tientsin, Shanghai, Nanking, and other industrial cities. More than 130 different models have been developed and now are being produced. Radios are high on the list of "prestige" exports and several brands have been offered for sale throughout the world.

In the field of wire broadcasting, much work is done by small local units on remodeling ordinary receivers into mother receivers with a number of loudspeakers. Usually dry-cell batteries or kerosene lamp thermoelectric generators are used for power; however, in late September 1958, Model GU 5725 wire-broadcasting equipment used an animal-powered machine to generate its electricity.

Many of China's broadcasting problems were solved—and probably still are—with the aid of the U.S.S.R., Czechoslovakia, Hungary, and East Germany; however, since the trial manufacture in 1956 of a group of 120-kilowatt shortwave transmitters, the Chinese have been able to manufacture high-power transmitting equipment. ("Trial production" or "manufacture" probably indicates that an item has been turned out by hand and does not imply that a trial run has been made on the assembly line.) It is reported, for example, that the Peiping Broadcasting Equipment and Materials Plant (*Pei-ching Kuang-po Ch'i-ts'ai Ch'ang*) trial-manufactured a 120-kilowatt shortwave transmitter, a copy of a Soviet type, operating in the range of 15 to 70 meters in four bands. The transmitter was produced and reportedly placed in service in four years counting the redesign phase.

China's first frequency-modulation broadcasting station began operations at Peiping on 1 January 1959. The station broadcasts on a frequency of 67.8 megacycles (4.43 meters).

In 1958 nine Shanghai plants in cooperation with the Academy of Science's Institute of Radio Techniques (*Wu-hsien-tien Chi-shu Yen-chiu-so*), Shanghai, trial-produced a semiconductor receiver. This institute probably gives considerable assistance to Shanghai's thriving radio industry.

b. SINGLE SIDEBAND — An experimental 200-watt sideband equipment was produced by the Posts and Telecommunications (Peiping?) Equipment and Materials Plant, sometime during 1957. See FIGURES 71-3 and 71-4. The telecommunications journal *Tien-hsin K'o-hsueh*, 1958, volume no. 6, contains a paper describing this device which appears to be based on U.S. equipment and

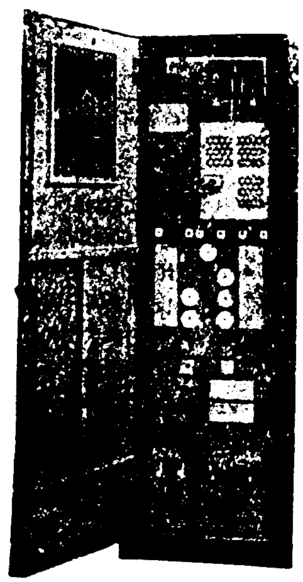


FIGURE 71-3. TRANSMITTING EQUIPMENT OF CHINESE SINGLE SIDEBAND EQUIPMENT

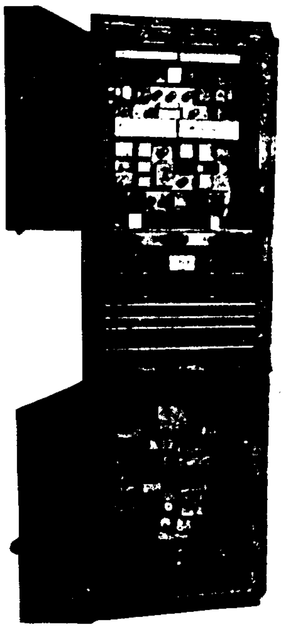


FIGURE 71-4. OUTPUT TERMINAL OF CHINESE SINGLE SIDEBAND EQUIPMENT

technology. "The authors choose the wideband crystal filter system for both their transmitter and their receiver, the pass band of the filter being 100.3 to 105 kilocycles and the carrier frequency in this case is 100 kilocycles. The frequency range of the transmitters is 3.5 to 21 megacycles. The receiver is a double conversional superheterodyne, and the first and third oscillators are crystal controlled. The intermediate frequencies employed are 355 and 100 kilocycles respectively."

c. MILITARY AND COMMUNICATION-TYPE RADIO — Very little is known of Chinese development and production in this field. In October 1957, the Chinese announced that radio communication equipment for jet airplanes had been produced. Reportedly, the quality of the equipment was completely adequate. A Chinese-developed high frequency communications receiver is shown in FIGURE 71–5.

In late 1958 radio communications equipment used by the Chinese Army reportedly was primarily Chinese in design and manufacture. It was supplemented by limited quantities of early post-World War II Soviet equipment. One source says that the Chinese-made items are usually modi-

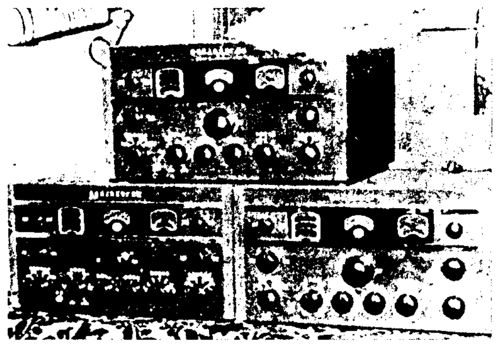


FIGURE 71–5. HIGH-FREQUENCY RADIO RECEIVER, 1958

fied copies of obsolete U.S. equipment. It is probable that the Chinese armed forces now are using Chinese-built equipment based on more modern Soviet and Western prototypes.

d. TELEVISION — In 1956 and again in 1959, the Chinese-Soviet Commission on Scientific-Technical Cooperation agreed that the Soviets would furnish the Chinese with technical documentation concerning construction of a television center. Chinese specialists were to visit Soviet organizations and become acquainted with the work of television and audio broadcast stations.

A preliminary plan for the establishment of a television station and the installation of television transmitter was completed in late 1956 or early 1957 by a design unit of the Soviet Ministry of Communications. Before the plan was made, a team from the design unit was at Peiping in 1956 for a thorough study of the locality and for collection of data. The plan was to be submitted to the Peiping authorities in March 1957.

China's first television transmitter was completed in early 1958 and formal operation began on 2 September 1958. Soviet experts as well as the Television Research Section of the Radio Electronics Department, Tsinghua University (*Ching-hua Ta-hsueh*), Peiping, and the Broadcast Scientific Research Institute (*Kuang-po K'o-hsueh Yen-chiu-so*) assisted the Peiping Broadcasting Equipment and Materials Plant in the trial manufacture of the transmitter. The 1-kilowatt transmitter operates with the video on 57.75 megacycles with a 6-megacycle bandwidth, and the audio on 64.25 megacycles. The scanning raster has 625 lines.

The Radio Department of the Ch'eng-tu Posts and Telecommunications Engineering College (*Ch'eng-tu Yu-tien-hsun Kung-ch'eng Hsueh-yuan*), Ch'eng-tu, reportedly was scheduled to set up an experimental television center and start telecasting before 1 May 1959. According to the Chinese, the department was to become one of the nation's research centers for the study of television, microwave problems, electromagnetism, and information theory. Nothing further is known of this project.

According to the Chinese, in 1958 the Peiping audience used television receivers made in the Soviet Union and Czechoslovakia. Receivers sold in 1959, however, were Chinese developed and manufactured. China's first television receiver was manufactured by the Tientsin Radio Plant (*T'ien-ching Wu-hsien-tien Ch'ang*), Tientsin. This set and a Soviet-made receiver were used at the first tryout of the Peiping transmitter on 17 March 1958.

A number of plants are now concerned with television receivers. One of the largest is the Shanghai Broadcasting Equipment and Materials Plant (popularly known as the Shanghai Radio Plant) (*Shang-hai Kuang-po Ch'i-ts'ai Ch'ang*). In mid-1958 the plant reportedly had completed the test manufacture of two Shanghai brand Model 101 17-tube television sets. The plant reportedly plans to test-produce popular model television sets, a color television set, a projector-type television set, and a combination television, record player, radio, and recording set. In late January 1960 the Chinese said that the plant had started serial production of the 18-tube "Shanghai" brand television set, built to its own design. The set could receive programs on five frequencies. All of its electronic tubes were made in China, except the picture tubes and "crystal tubes."

In 1959 the Shanghai Solar Energy Equipment Manufacturing Plant (*Shang-hai Tsi-yang-neng Ch'i-hsieh Chih-tsao Ch'ang*) reportedly manufactured 25 microwave antennas for the Peiping and Canton television stations. According to the Chinese, this was the first time that microwave antennas were manufactured in China.

2. Other communications

a. CARRIER-WAVE EQUIPMENT — The Chinese are expending enormous efforts on the development and production of carrier-wave equipment. According to the Chinese, the first native 12-channel carrier-wave equipment was manufactured by the Shanghai Long-Distance Telephone Office in August 1958. The equipment reportedly required only 38 days from design to completion. The equipment was designed according to the frequencies of Hungarian 12-channel carrier-wave equipment and utilizes crystal, narrow-band filters. All raw materials used were Chinese, and the transformers and attenuators were made in China. The Posts and Telecommunications Shanghai Equipment and Materials Plant aided in the project.

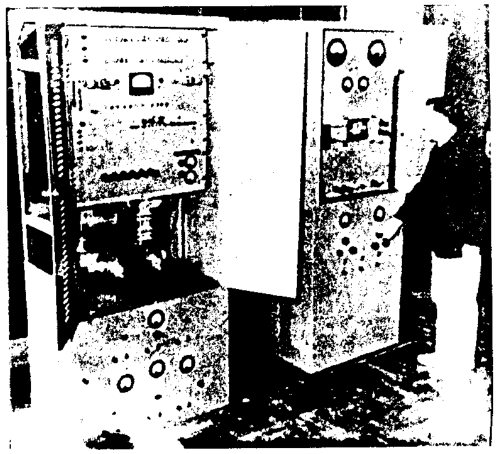


FIGURE 71-6. 240-CHANNEL MICROWAVE COMMUNICATIONS EQUIPMENT

By September 1958, 24-channel carrier-wave equipment had been trial-manufactured successfully by the Posts and Telecommunications Scientific Research Institute. In March 1959, the Chinese announced that the country's first 60-channel carrier-wave equipment had been produced by the Posts and Telecommunications Shanghai Equipment and Materials Plant (*Yu-tien Shang-hai Ch'i-ts'ai Ch'ang*), Shanghai. Future plans include production of 240-, 600-, and 1,000-channel carrier sets.

b. MICROWAVE RELAY EQUIPMENT — Sometime before October 1958, the first Chinese trial-manufacture of 240-channel microwave communication equipment reportedly was successfully completed by the Posts and Telecommunications Scientific Research Institute (*Yu-tien K'o-hsueh Yen-chiu-so*) at Peiping. The equipment was designed to operate in the 4,000-megacycle frequency band with a band width of 30 megacycles. A parabolic antenna is used in this equipment; the antenna gain reaches 40 decibels (see FIGURE 71-6).

According to the Chinese, the country's first set of 60-channel microwave relay equipment was produced by the Posts and Telecommunications Peiping Equipment and Materials Plant on 26 November 1958 after 68 days of work. The equipment has a frequency range of 1600–2000 megacycles and an output power of 3 watts; the effective distance is 50 kilometers.

Some microwave research appears to be conducted at the Institute of Electronics, Chinese Academy of Sciences, but details of this program are lacking.

c. TELEPRINTER AND FACSIMILE EQUIPMENT — In March 1956, a page-type Model 55 teleprinter was developed and manufactured by the Posts and Telecommunications Shanghai Equipment and Materials Plant. The structure of this machine is basically the same as that of a Siemens-Halske (West Germany) teleprinter. Model 55 conformed to the main specifications for teleprinter machines as approved by the Chinese Long-Distance Telecommunications Central Bureau (*Ch'eng-t'u Tien-hsien Tsung-chu*). These specifications are: "International standard code no. 2 will be adopted, the machine will activate 400 impulses per minute, the length of the stop pulse will be 1.5 times the unit pulse, and the speed of transmission will be 50 bauds." In using the Model 55 to transmit Chinese messages, the operator must convert the Chinese characters into the standard telegraphic code.* According to a Western observer who watched the Model 55 in operation, the printing mechanism of the machine appeared to be crude, and he believed it probable that other components of the machine, where more skill is demanded, were also inferior in quality to the Siemens original.

In November 1953, the Ministry of Posts and Telecommunications decided to produce Chinese-character teleprinter equipment that would eliminate coding and decoding. A detailed plan for producing such equipment was made in October 1954 and in June 1955 the trial manufacture of the equipment was completed. The equipment is composed of two units, the perforator and the printer—each having 4,096 Chinese characters. Both the perforator and printer are electronically controlled. See FIGURES 71–7 and 71–8.

During April 1958, officials of the Ministry of Posts and Telecommunications told a visitor that tests of two new pieces of equipment were then underway at the recently constructed Peiping Posts and Telecommunications building. One of the machines allegedly converted 4-digit telegraphic code numbers into characters; the other machine converted hand-written characters into the corresponding 4-digit code numbers. The machines were displayed but not in operation.

* To overcome the problem of transmitting Chinese characters in various forms of telecommunications, the Chinese Standard Telegraphic Code was developed. Four-digit groups from 0000–9999 are used to represent Chinese characters, one group to a character.

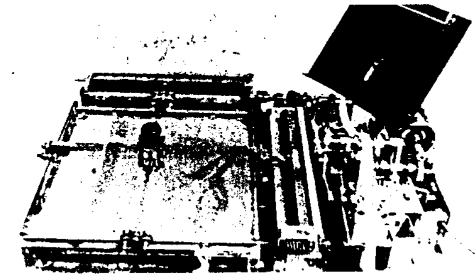


FIGURE 71–7. PERFORATOR FOR CHINESE CHARACTER TELEPRINTER

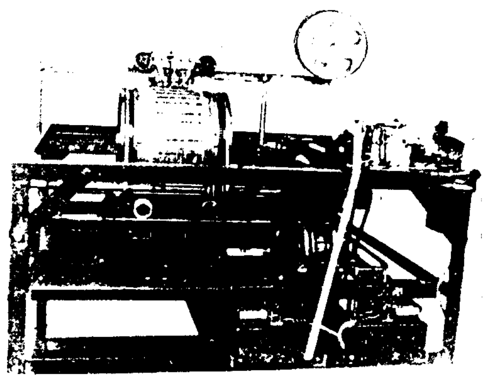


FIGURE 71–8. PRINTER FOR CHINESE CHARACTER TELEPRINTER

Chinese development of facsimile equipment began at least as early as 1955. On 21 April 1956, the Chinese announced that facsimile telegraphic equipment for transmitting Chinese characters, the first of its kind in the nation, was successfully completed on 14 April 1956 in Ch'ung-Ch'ing and had been put into experimental operation there.

In late 1956 an unidentified type of Chinese-made facsimile transmission equipment was described in a Japanese magazine. The equipment had the following characteristics:

Size of original paper: 128 x 180 millimeters; 12-millimeter-wide tape.
Diameter of transmission cylinder: 56.4 millimeters.
Length of cylinder: 132 millimeters.
Scanning width: 7 millimeters
Cylinder revolution: 5/3 r.p.m. [sic] (probably 1⅔ revolutions per second=100 r.p.m.)
Scanning numbers: 3.5 per 1 millimeter.
Carrier frequency: 1,700 c./s.

Highest picture frequencies: 206 c./s.
Coordinating work rate: 24.5 PM (P: helical wire pitch; M: number of scanning lines per 1 millimeter).
Adjustment level as the result of frequency variations in same period. (AC power source 2×10^2 to be done by friction coupling units.)

The Chinese facsimile equipment was a sub-carrier frequency modulation type, and its structure conformed to *Comité Consultatif International (Radio)* standards.

In 1956, the Chinese were considering a system with which newspapers throughout the country would be able to publish a given item simultaneously on the day it was announced. Further data on facsimile transmission of newspapers appeared in July 1958, when the Chinese announced that the Peiping Long-Distance Telecommunications Bureau recently had trial-manufactured the first [sic] telefacsimile set in China and that in the future, the Peiping People's Daily would be transmitted to various major cities by telefacsimile. The Chinese claimed that in order to telefacsimile a newspaper, ordinary sets had to cover one page in eight sections, whereas, the new set could do a whole page at one time. No description of the new machine was given.

Other activity may be concerned with the same device. By July 1958 the Peiping Long-Distance Telecommunications Bureau had introduced a single narrow-frequency-band telegraph-facsimile scanning machine. Research on facsimile devices began in 1955 at this same bureau. The research was directed toward solving problems in power sources that affect synchronized electric motors. Four improved facsimile machines were being produced in 1958; on completion, they were to be tested between Peiping and Tientsin. At this time (July 1958) a Japanese telecommunication journal also reported indications of preparations for facsimile publishing of newspapers throughout Communist China: "Facsimile equipment will be combined with Nakagawa Electric Company's automatic type-molding machine to print the same edition of the *People's Daily* for simultaneous nationwide distribution." During the spring of 1959, the Peiping Long-Distance Telecommunications Bureau and the Peiping Posts and Telecommunications Scientific Research Institute continued the study of facsimile transmission of newspapers.

A great deal of other research on facsimile equipment is underway in China, the most interesting of which is color transmission. In November 1958, the Chinese announced that a facsimile telegraph machine for transmission in color had been made by the Peiping Posts and Telecommunications College. The machine reportedly requires only one scanning and can transmit the various colors directly to photosensitive paper attached to the receiver. The machine was designed through adaptation of color television principles. According to the Chinese, this machine is simple in construction and easy to operate. They assert the trial model was completed in some 20 days [sic] despite the scarcity of materials to build such a machine.

d. LONG-DISTANCE WAVEGUIDE COMMUNICATIONS — Beginning in 1957, members of the Institute of Electronics, AS, have conducted investigations of long-distance waveguide communications. With the aid of Soviet waveguide specialists, Chinese two-year and five-year plans for research work were compiled in 1958. Chinese and Soviet waveguide dimensions, waveguide elements, and methods of measurements are now standardized to facilitate exchange of technical documentation on the electronic components. As one of the norms, an inner diameter of a waveguide equal to 60 millimeters was selected.

A committee composed of representatives of the Academy of Sciences, Ministry of Posts and Telecommunications, Ministry of Railroads, radio-production facilities and a number of other organizations was created to direct the work of long-distance waveguide communication in China. All scientific work is directed by the "Central Laboratory" (Institute of Electronics?) in Peiping, directly subordinate to the committee.

e. TELEPHONE — There have been no marked new developments in Chinese telephony. In mid-1957, buildings of the Peiping Telecommunications Equipment Plant (*Pei-ching Yu-hsien-tien Ch'and*), Peiping, were completed and the most important equipment had been installed. Trial production and full-scale production of the first automatic telephone switchboards produced in China were begun. The plant was built with Soviet aid. All major equipment and precision equipment were supplied by the U.S.S.R. During construction, many Soviet experts in construction techniques, equipment installation, and production were sent to assist.

Telephone equipment is produced also by the Ch'ang-ch'un Telephone Equipment Plant (*Ch'ang-ch'un Tien-hua-chi Ch'ang*) in Canton.

f. IONOSPHERE RESEARCH — The physical properties of the ionosphere and their effect on electromagnetic wave propagation are being investigated by the Ionosphere Division of the Geophysical Observatory (*Ti-ch'iu Wu-li Kuan-hsiang-t'ai*), Wuhan Branch of the Chinese Academy of

Sciences. According to the Chinese, a net of ionospheric stations is in charge of vertical sounding for measuring the height of a reflecting layer and the degree of its ionization, and of studying the ability of the ionizing layers to reflect various particles. In late 1959 the Chinese announced some success in the development of ionospheric-scatter communications equipment. See SECTION 76 of this NIS for related information.

3. Navigation aids

Very little information is available on Chinese work with this type of equipment. The August 1959 issue of *Ts'e-liang Chih-t'u Hsueh-pao* (Journal of Geodetics and Cartography) stated that work on a domestically manufactured airborne "radar," the ZWCH-1 (an imitation of a Soviet system), was conducted at the Institute of Geodesy and Cartography (*Ts'e-liang Chih-t'u Yen-chiu-so*), Wu-ch'ang, Chinese Academy of Sciences. The article describing the unit was written under the direction of Soviet specialists and was based on both pertinent references and on the experience of the Chinese writers. The writers indicated a need for further research. Although both the Chinese text and Russian-language extract of the article specifically refer to this equipment as "radar," the device would not be considered as such in the United States. Instead, the article refers to the airborne portion of a phase-comparison (hyperbolic) navigation system, basically similar to the British Decca System. Such a system plots the position of the carrying aircraft accurately (within several wavelengths) and automatically.

4. Radar other than navigation aids

Interest in radar can be traced back to the earliest days of the Chinese Communist regime. A Radar Institute (*Tien-ta Yen-chiu-so*), for example, was located in 1950 at Nanking. In addition to a considerable number of radars supplied by the U.S.S.R. and a few by East Germany, the Chinese inherited a number of Japanese and U.S. radars. The Chinese also are attempting to obtain Western radars—in 1958, for example, marine radar and meteorological radar, and in early 1959, L-, S- and Q-band radar.

The Chinese learned to maintain various types of radars during the war and afterwards. In addition, they probably began to make some radar parts as early as 1951 or 1952. Development and production of complete radars probably began about 1956. The earliest known Chinese claim of radar production is a statement in the 27 October 1957 issue of *Tien-hsin K'o-hsueh* (Science of Telecommunications) that "radar for maritime use and for national defense" already had been produced. A year later, another Chinese source said that radar had been "produced by modern plants."

The first eye-witness report of what may have been a Chinese-made radar occurred in mid-July 1958 when a visitor to Canton saw a mobile radar unit on display at a park. A demonstrator said the radar was built in China. As displayed, the unit consisted of a scanner mounted on a low platform trailer and two caravan-type control trucks. All three units were linked by cables. According to an interrogation of the source the scanner was a flat frame covered by a fine wire mesh and measured about 40 feet long and 30 feet high. This was mounted on a pedestal on which it revolved. The visitor estimated that it made one revolution every five or six seconds. The simplicity of the radar scanner caused the observer to believe that it might have been a dummy. The information furnished by this source is obviously too meager for identification purposes and, in addition, it is quite possible that the device may have been a dummy. There is a possibility that the source was mistaken in describing the scanner as a "flat frame"; if the frame were parabolic, then the entire assembly would be related to a bulldozer type of radar reflector; however, the source does not mention the presence of a dipole or a waveguide as integral to the scanner.

The next radar observed, the CROSS SLOT, is the only Chinese developed and produced radar on which reasonably complete data are available. This radar was first seen in 1958 when photographs were obtained of a radar installation located at Tai-mei Shan, a site formerly occupied by a Soviet TOKEN radar. CROSS SLOT consisted of a cut paraboloid antenna mounted on a tower and fed by a coaxial cable from a building adjacent to the tower. See FIGURE 71-9. Photo interpretation indicated that the antenna was approximately 16 feet long and 5 feet high, constructed of screening supported by either tubular or shaped structural members mounted on a rotor. Predominant signal characteristics of this radar are:

Frequency: 2980–3080 mc./s.
Pulse repetition frequency: 350–450 p.p.s.
Pulse width: 1.0–2.2 microsecond.
Antenna rotation: manual.
Polarization: horizontal.

Original photographic studies from Tai-mei Shan indicated a height finder at the site. This suggested possible use as a ground controlled intercept system; however, subsequent sightings with one exception have been in coastal locations, indicating a probable early-warning surface-search utilization. If this radar were used in a ground controlled intercept mode, its probable

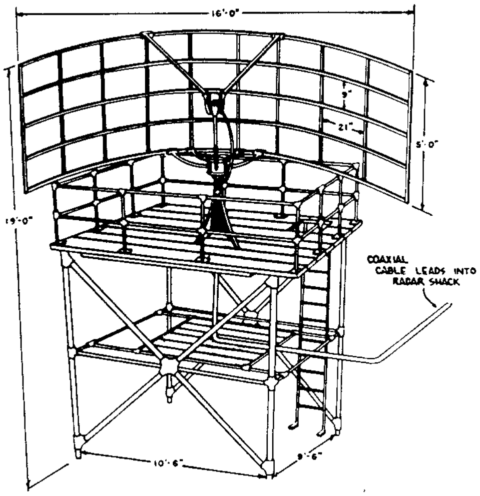


FIGURE 71–9. CHINESE CROSS SLOT RADAR

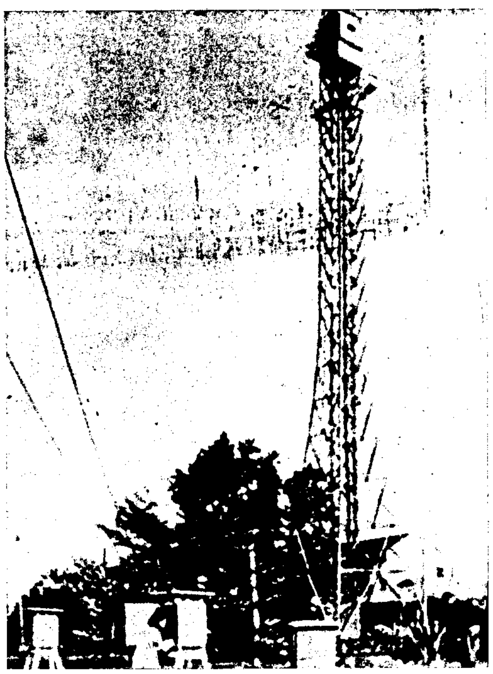


FIGURE 71–10. RADAR USED BY THE SHANGHAI CENTRAL METEOROLOGICAL STATION

range would be less than that of TOKEN; in a surface-search mode, its capability would probably exceed that of BEEHOUSE.

An overall photograph of a radar developed and manufactured in China and used by the Shanghai Central Meteorological Station is shown in FIGURE 71–10. According to the Chinese, the device has a range of 400 kilometers (240 miles).

No confirmed intelligence is available to show where Chinese radars were developed and manufactured. Considerable weight can be given, however, to the hypothesis that Chinese radars are manufactured at the Nanking Radio Plant (*Nanching Wu-hsien-tien Ch'ang*). A number of sources including one of reasonably high order have placed radar production at Nanking. The Institute of Electronics of the Chinese Academy of Sciences reportedly bought two 3-centimeter radars at Nanking. In addition, the Radar Institute reported to be in Nanking in 1950 may still exist, and some work on special purpose tubes such as traveling-wave tubes is conducted at Nanking. As for the Nanking Radio Plant, two low-grade sources reported radar production there; what is known of the plant makes radar production possible; and by February 1959 the porcelain shop of the plant reportedly produced "high-frequency porcelain for parts in Class I communications receivers, aviation radio stations, and jet airplanes."

Several other facilities and organizations are of interest in connection with the development and production of native Chinese radar. One of them is the San-ying Electrical Industry Plant (*San-ying Tien-yeh Ch'ang*), Shanghai. In late 1958, in addition to such items as copper printing rollers and seamless copper tubings, this plant manufactured television microwave tubing, semiconductor receiver printer circuits, and radar waveguides. In mid-1958 a Radar Bureau, General Ordnance Department, was probably under the Ministry of National Defense, but no details of the bureau are known.

5. Infrared devices

In July 1957, the People's Liberation Army exhibited "many new weapons which had never been before exhibited in public." Naval equipment shown included infrared direction finders. Although the Chinese are capable of developing and manufacturing infrared devices, this particular equipment may have been obtained from the Soviet bloc.

In recent years, the growth of Chinese work on infrared absorption spectroscopy has been particularly rapid. At Peiping University (*Pei-ching Ta-hsueh*), Peiping, monocrystals reportedly are being grown for infrared spectroscopic devices, but no details of this work are known.

6. Underwater acoustics

Chinese underwater acoustics research apparently centers on the work of Ma Ta-Yu of the Institute of Electronics, Chinese Academy of Sciences. To facilitate this research, at least two "fairly large coastal boats" at Tsingtao and a laboratory with a large tank and underwater noise generators at Peiping are available. Research is said to involve the use of quartz crystals, essential for the manufacture of sensitive directional transducers. It is known that China is manufacturing echosounders, one recording type having been developed by the Yangtse Water Conservation Committee.

7. Computers

The Chinese completed their first large high-speed digital computer early in 1959. This computer, a copy of the Soviet BESM II, was constructed from Soviet plans and with Soviet technological support. See FIGURE 71–11. A few other copies of Soviet models of small digital computers are available in geographically scattered locations. Among these are a copy of the Soviet M–2 computer at the Northeast (Polytechnic) Engineering College (*Tung-pei* (*To-k'o-hsing*) *Kung-hsueh-yuan*), Mukden, and a copy of the Soviet M–3 computer (Chinese name is "August 1 model") at the Institute of Computation Techniques (*Chi-suan Chi-shu Yen-chiu-so*) in Peiping. Both of these computers were constructed from Soviet plans and with the aid of Soviet specialists. See FIGURES 71–12 and 71–13. There are also Soviet URAL computers at unknown locations, one of which may be at the Harbin (Polytechnical) Engineering College (*Ha-erh-pin* (*To-k'o-hsing*) *Kung-hsueh-yuan*), Harbin. These URAL computers were direct imports and, to date, Chinese scientists have made only minor improvements upon Soviet work. Development of original Chinese models is not included in the present Twelve Year Plan and is unlikely until after immediate needs of priority projects have been satisfied.

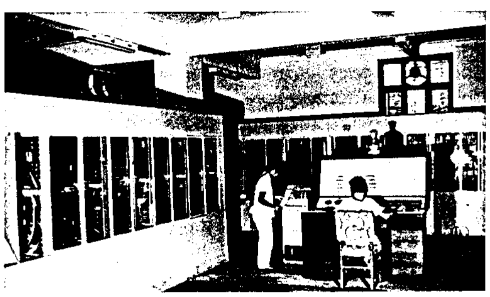


FIGURE 71–11. CHINESE COPY OF SOVIET BESM II DIGITAL COMPUTER, 1959

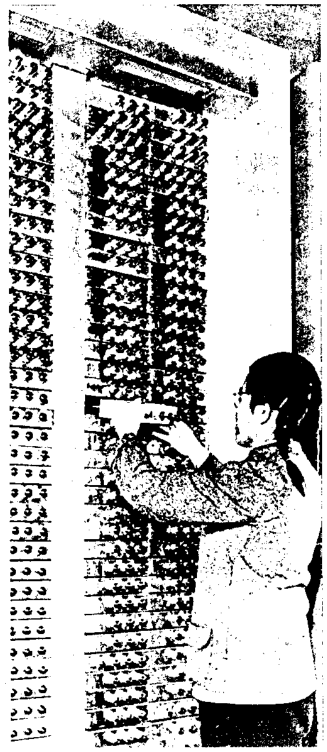


FIGURE 71–12. COPY OF SOVIET M–2 COMPUTER MADE BY TEACHERS AND STUDENTS AT NORTHEAST (POLYTECHNIC) ENGINEERING COLLEGE

FIGURE 71–13. CHINESE "AUGUST 1" DIGITAL COMPUTER, 1958

In several instances, Chinese educational industrial organizations have reported development of analog computers. All of these are fairly small machines, apparently intended for use by engi-

FIGURE 71–14. ANALOG COMPUTER "FU TAN 601" BUILT AT FU TAN UNIVERSITY

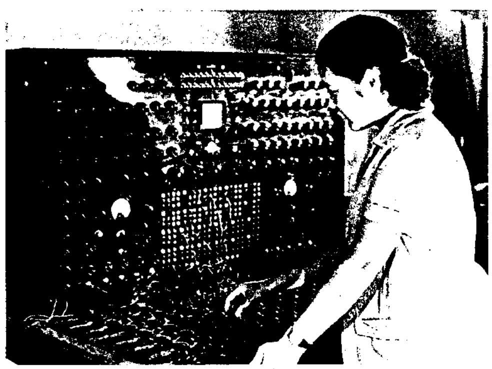


FIGURE 71–15. ANALOG COMPUTER DESIGNED AND BUILT AT HARBIN (POLYTECHNICAL) ENGINEERING COLLEGE

neers engaged in industrial developments. None display features more advanced than those of analog computers available in the West and in the U.S.S.R. several years ago. See FIGURES 71–14 and 71–15.

There is considerable emphasis on applications of computers in support of projects of military and economic importance in China. The Peiping University and the Tsinghua University have sections concerned with computer mathematics. These, along with the Institute of Mathematics (*Shu-hsueh Yen-chiu-so*), AS, Peiping, have cooperated with the Institute of Computation Techniques in undertaking development of methods and techniques for computer applications. This work is just getting underway and is still highly dependent on the U.S.S.R. for support. Most of the applications reported to date are typical engineering and scientific applications such as computing solutions of problems arising in connection with construction of dams and large structures. Some application of computers to economic planning problems has begun and some work on machine translation of languages, especially Russian to Chinese, is underway. There are limited indications of military interest in computers but no specific military applications have been described.

8. Electronic countermeasures

No intelligence is available on Chinese Communist development of electronic countermeasure devices but such development is within their capabilities. One firm report of electronic jamming by the Chinese Communists is known. On 30 October 1958 Nationalist Chinese radar stations reported active jamming from an airborne source for 17 minutes. Jamming evidently originated from eight Chinese Communist aircraft, probably IL–28's, active about 20 miles north of (Chingmen) Kingmen during the incident. The equipment involved was height finding and to a lesser degree, search radars. The Chinese Communist aircraft were seen through the jamming. Experienced U.S. officers at the radar sites stated that jamming definitely occurred and originated from Chinese Communist aircraft. The equipment used may have been either Chinese- or bloc-developed. The Communist Chinese frequently have used chaff.

9. Vacuum tubes and semiconductor devices

a. VACUUM TUBES — In addition to a wide variety of ordinary vacuum tubes, the Chinese claim to have developed and manufactured special tubes such as traveling-wave tubes and magnetrons. Probably only a few of this latter type are produced at present. Ordinary vacuum tubes are based principally on foreign prototypes; in general, tubes developed at the Peiping Electron Tube Plant are adapted from Soviet models; those at the Nanking plants from U.S. types. See FIGURES 71–16 and 71–17.

Tests performed on receiving tubes manufactured in Communist China during 1958 (probably at the Peiping Electron Tube Plant) show that: a) internal cleanliness, especially of stem

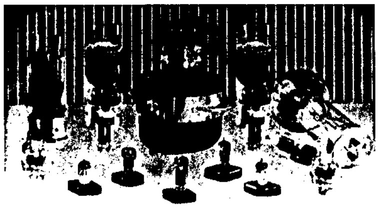
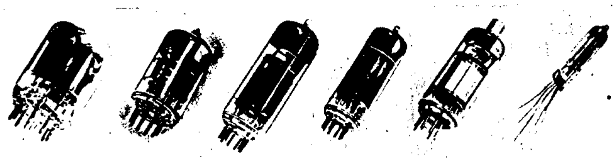


FIGURE 71–16. VACUUM TUBES MANUFACTURED AT PEIPING ELECTRON TUBE PLANT



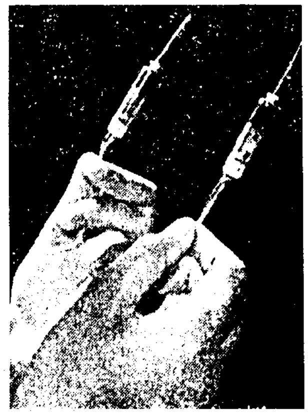


FIGURE 71–17. TESTING A TELEVISION TUBE AT NANKING ELECTRON TUBE PLANT

leads, is usually good; b) despite rather thick and somewhat overmelted seals, the glass construction is very good, showing excellent color of Dumet leads and stems; c) the cage assembly is well supported and positioned with ample tabs on the elements; the use of molybdenum grid wires should produce tubes with very low microphonics and resonant frequencies; d) grid laterals of molybdenum were found in all tubes, even those for which, in Western practice, molybdenum would be considered unnecessary; and e) in two tubes, the control grid had been stretch-formed over a 60-mil cylindrical mandrel forming a cylindrical control surface for presentation to the cylindrical cathode. This technique of grid forming has been employed widely for only about five years in the United States.

Development and production of vacuum tubes at very small units may form a part of the Chinese vacuum tube industry. During April 1951 the Chinese press referred to a Shanghai facility, the Tien-t'ung Vacuum Tube Experimental Plant (*Tien-t'ung Chen-k'ung-kuan Shih-yen-ch'ang*). No further reference to this facility is known until 1958 when a Chinese broadcast stated that "the Tien-t'ung Electron Tube Plant of Shanghai, with only nine workers, . . . turned out good quality electron tubes and vacuum gauges." High-grade engineering development would be required before vacuum tubes could be produced with only nine workers, but such production is feasible. Although inefficient by Western standards, such a tube factory would correspond with the Chinese desire to have a large number of very small-scale production units in some technical fields.

With respect to more fundamental vacuum tube research, the Institute of Electronics was working in mid-1959 on klystrons, magnetrons, and traveling-wave tubes. Reportedly the institute was anxious to produce 4-mm. and 8-mm. tubes. (One traveling-wave tube had been produced but the noise level was too high.) No other details of this research are known, except that some difficulties were being encountered. The institute was

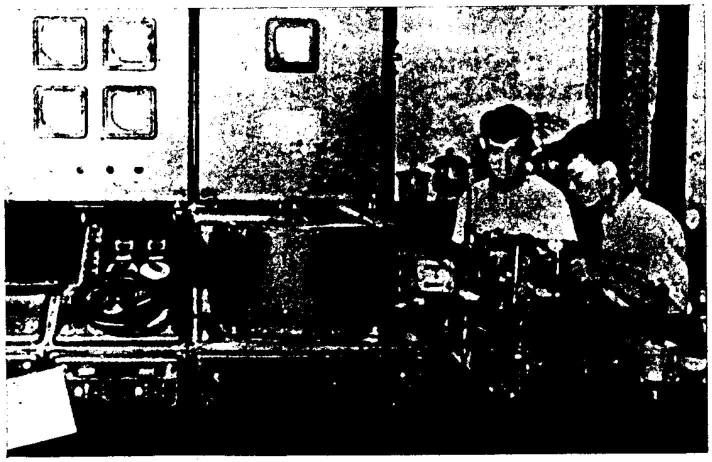


FIGURE 71–18. LABORATORY OF SEMICONDUCTORS, CHINESE ACADEMY OF SCIENCES

also interested in making transmit-receive switches for sub-millimeter wave radar, but in 1959, work had not started.

For a number of years, investigations have been conducted at the Institute of Electronics on various types of cathodes, and a simplified new procedure for barium-tungsten cathode preparation has been found. Emission, evaporation, poisoning, secondary electron emission, and durability characteristics are probably comparable with those attained in the West.

Some research on and production of vacuum tubes have been conducted at higher educational institutions since the early days of Communist China. Beginning in 1957, work on a traveling-wave tube, beam power tubes, and hydrogen-filled thyratrons was done at the Nanking Engineering College (*Nan-ching Kung Hsueh-yuan*), Nanking. In 1948, Lu Chung-tso (7120/6945/4373), a member of the college, wrote a book, *Super-high-frequency Electron Tubes*. To link teaching with scientific research and production, electronics tubes were among items turned out by Tsinghua University at Peiping and by other educational facilities. In addition, small-scale vacuum tube production as well as some research and development are probably conducted at the Peiping Posts and Telecommunications College (*Pei-ching Yu-tien Hsueh-yuan*), Peiping. In October 1957, a course on machines and equipment for manufacturing electronic tubes was established in the Peiping School of Radio Industry for training technical personnel to design, improve, maintain, and manufacture the various machines and equipment for making electronic tubes.

b. SEMICONDUCTOR MATERIALS AND TRANSISTORS — According to the Chinese press and radio, semiconductor devices and transistors are now being used widely. It is believed that the Chinese tend to refer to all semiconductor devices as "transistors," and many of the units described by them as transistors are almost certainly diodes, which are much simpler to manufacture.

The first Chinese work on semiconductor materials and transistors began about 1953 and has continued with increasing emphasis. At present at least 16 facilities are concerned with research, development, and production in this field, and there are probably many more. The Institute of Physics with its Laboratory of Semiconductors is the most important research facility (see FIGURE 71–18). Other facilities include educational institutions such as Peiping University (FIGURE 71–18); the Institute of Electronics; the Peiping Posts and Telecommunications Research Institute; the Peiping Electron Tube Plant; and the North China Radio Equipment and Materials Plant at Peiping. See FIGURE 71–19.

Progressing from their early work on copper oxide rectifiers and lead and cadmium sulfide photoconductors, the Communist Chinese began the extraction and refining of germanium in 1956. This was followed by the production of semiconductor devices, such as diodes and transistors. By 1958 they were using native materials for the production of fairly large quantities of germanium single crystals and had gained considerable experience in the extraction and purification of silicon. Recent evidence indicates the successful production of a variety of germanium transistors

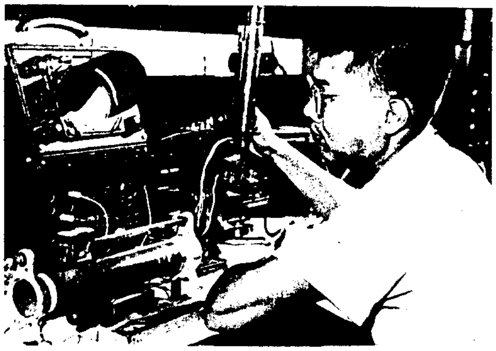


FIGURE 71–19. SEMICONDUCTOR "FACTORY" AT PHYSICS DEPARTMENT OF PEIPING UNIVERSITY

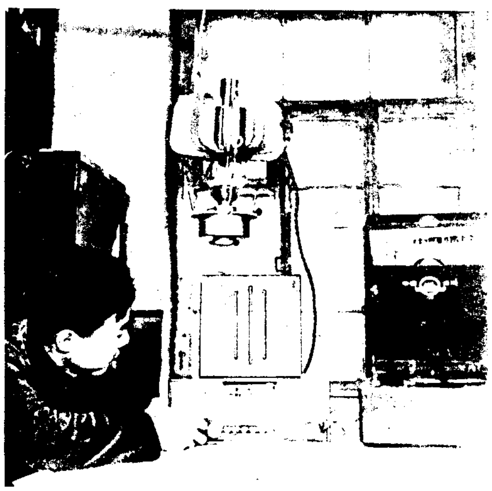


FIGURE 71–20. THERMOELECTRIC GENERATOR TRIAL PRODUCED IN HARBIN

with frequencies up to several hundred megacycles per second. In addition, other manufactured semiconductor devices include photoconductors, thermistors, photoelectric cells, and 2–10-watt thermoelectric generators. An example of a Chinese-modified Soviet semiconductor thermoelectric generator is shown in FIGURE 71–20. The device converts the heat energy of a lamp into electric current used to operate home radio receivers, etc. A large number of such generator-receiver sets have been produced, it is reported, and distributed to areas without electric power as a proof of Chinese scientific progress and as an effective tool for their propaganda.

10. Other electronics components

Minor facilities for manufacturing electronics components existed in a number of Chinese cities before World War II, but volume production of these items did not begin until October 1957 when the North China Radio Equipment and Materials Plant began operations at Peiping. Products developed and produced at the plant include paper, ceramic, and mica capacitors; electrolytic capacitors; carbon resistors, carbon potentiometers; glazed-wire resistors, ceramic parts; speakers and microphones; electric meters; and selenium rectifiers. During the first half of 1957, the plant began quantity production of constant magnetic ceramics, the first produced in China.

In June 1959, the Chinese announced that the I-pin Radio Equipment and Materials Plant (*I-pin Wu-hsien-tien Ch'i-ts'ai Ch'ang*) had recently manufactured a microminiaturized ceramic dielectric capacitor. "This type of capacitor is made from ferroelectric materials with a high dielectric constant in tubular and disc shapes. Its outer diameter measures only about 1 millimeter, and its maximum weight is only 0.0013 gram, which is only $\frac{1}{230}$ the weight of the miniature type of ceramic dielectric capacitor that is also a product of this plant. Its maximum capacitance may reach 1,000 micromicrofarad and it may be used at temperatures from $-60°$ to $+85°$ C., at a relative humidity as high as 98%, and at atmospheric pressures up to 40 millimeters on the barometer." If the Chinese claims are substantially correct, production of the microminiaturized capacitor represents a very high technical level.

a. ELECTRONIC INSTRUMENTS — There is evidence that during the four-year period, 1957–60, the Chinese planned to produce sufficient measuring instruments (as opposed to precision instruments) so that import of these instruments would no longer be necessary. At the same time, they said that research already in progress on instrumentation for automatic regulation and remote control would continue but would not be emphasized until 1961–64. The overall plan presupposed some specific items of foreign aid; East Germany, for example, was to supply specialized devices for measuring heat.

Although the Chinese claimed in early 1960 to be self-sufficient in instruments and meters of all kinds, they still are attempting to obtain a number of electronics items from the West. Some of this equipment may be required to replace existing units; others to be used as prototypes for reproduction by the Chinese. The Chinese have made many claims of high precision in their instruments and meters and such claims are probably substantially true.

b. AUTOMATICS AND REMOTE CONTROL DEVICES — Practically the only source of information on automatics and remote control are papers that appear in the journal *Tzu-tung-hua* (Automation) edited by the Preparatory Committee of the Automation Society of China. Among original Chinese articles published by this journal from October 1957 to February 1959 were papers concerned with the following: 1) circuit analysis of the automatic null point-type operational amplifier used in the DMZ–2 computer built by the Institute of Automation and Remote Control, Chinese Academy of Sciences; 2) 1955 Chinese research on a three-phase power magnetic amplifier, such as is used in an electromagnetic-type voltage regulator; 3) a contactless remote signaling system and a pulse frequency modulated telemetering system of Chinese design; 4) a comparative analysis of various types of error-detecting and error-correcting receiving circuits reportedly suitable for either systematic or nonsystematic codes, but not both; 5) simplified methods for calculating complex parallel and series selsyn circuits; 6) proposed engineering method for sequential relay circuits; and 7) a method for the synthesis of feedback control systems. All these papers were written by members of the Institute of Automation and Remote Control (*Tzu-tung-hua Chi Yuan-chu-li Ts'ao-tsung Yen-chiu-so*), Peiping, except the last—the author of this paper was from Chiao-t'ung University.

C. Significant research and development facilities

(See FIGURE 71–21 for a glossary of Chinese organizations concerned with electronics.)

Institute of Computation Techniques (*Chi-suan Ch'i-shu Yen-chiu-so*), *Peiping*—Acting director probably Yen P'ei-lin since 1958; formerly (1956–58) under the direction of Min Nai-ta, who defected to the West in 1959. The institute is subordinate to the AS. Most of the Chinese capabilities for computer development are concentrated

FIGURE 71–21. GLOSSARY OF CHINESE COMMUNIST ORGANIZATIONS CONCERNED WITH ELECTRONICS

Broadcast Scientific Research Institute (*Kuang-po K'o-hsueh Yen-chiu-so*).
Ch'ang-ch'un Telephone Equipment Plant (*Ch'ang-ch'un Tien-hua-chi Ch'ang*), Canton.
Ch'eng-tu Posts and Telecommunications Engineering College (*Ch'eng-tu Yu-tien-hsun Kung-ch'eng Hsueh-yuan*), Ch'eng-tu.
Chinese Academy of Sciences (*Chung-kuo K'o-hsueh-yuan*), AS, Peiping.
East China Electron Tube Plant (*Hua-tung Tien-tzu-kuan Ch'ang*), Nanking.
Harbin (Polytechnical) Engineering College (*Ha-erh-pin (To-k'o-hsing) Kung-hsueh-yuan*), Harbin.
Institute of Automation and Remote Control (*Tzu-tung-hua Chi Yuan-chu-li Ts'ao-tsung Yen-chiu-so*), Peiping.
Institute of Computation Techniques (*Chi-suan Chi-shu Yen-chiu-so*), Peiping.
Institute of Electronics (*Tien-tzu-hsueh Yen-chiu-so*), Peiping.
Institute of Geodesy and Cartography (*Ts'e-liang Chih-t'u Yen-chiu-so*), Wu-ch'ang.
Institute of Mathematics (*Shu-hsueh Yen-chiu-so*), Peiping.
Institute of Physics (*Wu-li Yen-chiu-so*), Peiping.
Institute of Radio Techniques (*Wu-hsien-tien Chi-shu Yen-chiu-so*), Shanghai.
I-pin Radio Equipment and Materials Plant (*I-pin Wu-hsien-tien Ch'i-ts'ai Ch'ang*), Peiping.
Ministry of Posts and Telecommunications (*Yu-tien Pu*).
Nanking Electron Tube Plant (*Nan-ching Tien-tzu-kuan Ch'ang*), Nanking.
Nanking Engineering College (*Nan-ching Kung Hsueh-yuan*), Nanking.
Nanking Radio Plant (*Nan-ching Wu-hsien-tien Ch'ang*), Nanking.
North China Radio Equipment and Materials Plant (*Hua-pei Wu-hsien-tien-tzu Ch'i-ts'ai Ch'ang*), Peiping.
Northeast (Polytechnic) Engineering College (*Tung-pei (To-k'o-hsing) Kung-hsueh-yuan*), Mukden.
Peiping Broadcasting Equipment and Materials Plant (*Pei-ching Kuang-po Ch'i-ts'ai Ch'ang*), Peiping.
Peiping Electron Tube Plant (*Pei-ching Tien-tzu-kuan Ch'ang*), Peiping.
Peiping Long-Distance Telecommunications Bureau, Peiping.
Peiping Posts and Telecommunications College (*Pei-ching Yu-tien Hsueh-yuan*), Peiping.
Peiping Telecommunications Equipment Plant (*Pei-ching Yu-hsien-tien Ch'ang*), Peiping.
Peiping University (*Pei-ching Ta-hsueh*), Peiping.
Posts and Telecommunications (Peiping) Equipment and Materials Plant, Peiping.
Posts and Telecommunications Scientific Research Institute (*Yu-tien K'o-hsueh Yen-chiu-so*), Peiping.
Posts and Telecommunications Shanghai Equipment and Materials Plant (*Yu-tien Shang-hai Ch'i-ts'ai Ch'ang*), Shanghai.
Radar Institute (*Tien-ta Yen-chiu-so*), Nanking.
San-ying Electrical Industry Plant (*San-ying Tien-yeh Ch'ang*), Shanghai.
Shanghai Light Bulb Plant (*Shang-hai Teng-p'ao Ch'ang*), Shanghai.
Shanghai Radio Plant or Shanghai Broadcasting Equipment and Materials Plant (*Shang-hai Kuang-po Ch'i-ts'ai Ch'ang*), Shanghai.
Shanghai Solar Energy Equipment Manufacturing Plant (*Shang-hai T'ai-yang-neng Ch'i-hsieh Chih-tsao Ch'ang*), Shanghai.
Shanghai Telecommunications Research Institute (*Shang-hai Tien-hsin Yen-chiu-so*), Shanghai.
Southwest Radio Equipment and Materials Plant (*Hsi-nan Wu-hsien-tien Ch'i-ts'ai Ch'ang*), Ch'eng-tu.
Tientsin Radio Plant (*T'ien-ching Wu-hsien-tien Ch'ang*), Tientsin.
Tien-t'ung Vacuum Tube Experimental Plant (*Tien-t'ung Chen-k'ung-kuan Shih-yen-ch'ang*), Shanghai.
Tsinghua University (*Ching-hua Ta-hsueh*), Peiping.
Wu-han Geophysical Observatory (*Ti-ch'iu Wu-li Kuan-hsiang-t'ai*), also called Institute of Upper Atmosphere Physics, near Hankow.

in this institute, in which the major achievement to date has been the construction and operation of a large high-speed digital computer, a copy of the Soviet BESM II. Current activities are strongly oriented toward training and toward developing the skills needed to construct and operate copies of Soviet computers. Development of techniques needed to use computers in support of Chinese economic and military programs is also accented. Currently, no work is being done to develop original models of computers; research is confined to restudying accomplishments from other countries, mostly Soviet, in order to make minor improvements and to adapt the developments for Chinese use. Capabilities for making components for use in computers are being established and construction of several copies of Soviet models including the BESM II, M–20, and M–3 computers, is being undertaken. The staff numbers about 200 persons, including about 100 recent graduates and 15–20 more experienced specialists. In addition to AS personnel, the institute includes people from military, industrial, and educational organizations.

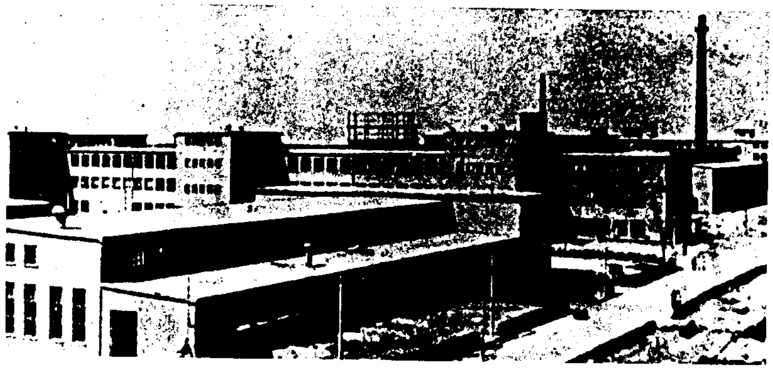
Institute of Electronics (*Tien-tzu-hsueh Yen-chiu-so*) *7193/1311/1331/4282/4496/2076,* Peiping*—Director: Ku Te-huan since July 1958. Deputy directors in 1959: Ma Ta-yu and Ko Ying-chang. The institute is subordinate to the AS. Plans for the establishment of the institute were announced in mid-1956 and actual establishment took place in late 1956 or early 1957. The Electronics Section of the academy's Institute of Physics probably formed the principal basis of the new institute. The institute has the following scientific departments: transistor electronics; wave propagation; ultrasonics; electroacoustics; electronics instruments; radio (including satellite tracking); microwave; chemistry; electron tubes; and electronics. The electronics department is subdivided into five groups: oxide-cathode; electroluminescence; electron-optics; thermonuclear research; and generation of micro- and sub-millimeter waves. In addition, the institute has five workshops. Although the total staff of the institute reportedly numbers about 2,000, there are only 20 senior scientists.

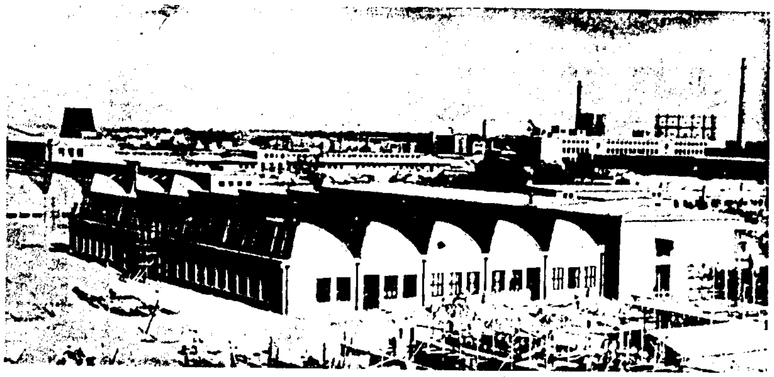
Institute of Physics (*Wu-li Yen-chiu-so*), *Peiping*—Director: Shih Ju-wei since 1954. Subordinate to the AS, this institute was formerly called the Institute for Applied Physics. The major departments or laboratories of the institute are concerned with semiconductors, metal physics, crystallography, solid-state luminescence or radiation physics, low-temperature physics, magnetism, and X-ray or spectral analysis (spectroscopy). Major achievements have been in the field of applied solid state physics and metal physics, as these subjects relate to the practical technological problems of electronics and metallurgy. In mid-1957, personnel numbered about 300, of whom 110 were research workers and 40 technicians or laboratory assistants. The work of the institute is of fairly high caliber, but is hindered by lack of equipment and experienced personnel.

North China Radio Equipment and Materials Plant (*Hua-pei Wu-hsien-tien-tzu Ch'i-ts'ai Ch'ang*) *5478/0554/3541/4848/7193/1311/0892/2624/1681, Peiping*—This plant was built with East German assistance. Initial planning started in 1952 and construction began in September 1954. Ninety percent or more of the materiel for the plant was furnished by the East Germans. Among other items, they are reported to have delivered 4,000 machines, installations, and fittings, 5,800 pieces of measuring equipment, 35,000 special tools and devices, and 10,000 ordinary tools. Some of this materiel almost certainly was obtained illegally from the West. Altogether, 230 German specialists went to China in connection with the plant and 70 Chinese were sent to East Germany for periods ranging from 6–18 months. Modern laboratories are attached to each of the three principal work areas of the plant. In addition, the plant has a large central laboratory, which the East Germans expected to become the center for Chinese scientific research in telecommunications and high-frequency engineering. See FIGURE 71–22.

Peiping Electron Tube Plant (*Pei-ching Tien-tzu-kuan Ch'ang*) *0554/0079/7193/1311/4619/1681, Peiping*—Probably subordinate to the First Ministry of Machine Industry. During erection of this plant the Soviets assisted the Chinese in surveying the site, constructing buildings, and installing machinery and equipment of very high quality and of the latest type manufactured by the U.S.S.R. The miniature tube exhaust machines appear to be quite sophisticated and the design of the test equipment for receiving tubes above average. The "snow white" rooms at the plant indicate some sophistication in the control of dust in tube assembly areas. The plant emphasizes production of tungsten and molybdenum filaments. The up-to-date drawing machines are said to be capable of making extremely thin filaments within 1½ seconds; some filaments have a diameter of only 12 microns. In addition to a number of well-equipped laboratories for testing chemicals and other materials used in produc-

* Standard Telegraphic Code (STC) numbers, numerical representations of Chinese characters, are given for the names of those organizations for which Chinese characters are available.





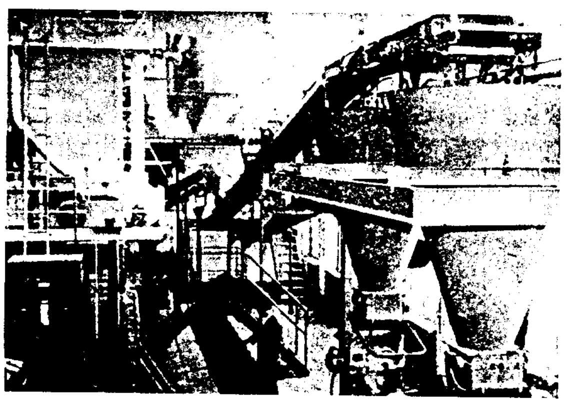


FIGURE 71–22. EXTERIOR VIEWS AND EQUIPMENT OF NORTH CHINA RADIO EQUIPMENT AND MATERIALS PLANT, PEIPING

FIGURE 71–23. PEIPING ELECTRON TUBE PLANT

tion, the plant includes facilities for engineering development where foreign vacuum tubes are adapted to Chinese manufacturing conditions. When the plant opened, one of its most important functions was to be "experimental production of tubes and equipment of many types." Some of this "equipment" is known to be transistors. In late 1958, a representative of the plant said that only a few research scientists were actually attached to the plant. See FIGURES 71–23 and 71–24.

Peiping Posts and Telecommunications College (Pei-ching Yu-tien Hsueh-yuan) 0554/0079/6755/7193/1331/7108, Peiping—Subordination of this college is unknown but it is probable that the Ministry of Posts and Telecommunications has considerable control over its activities. The college contains a Radio Communications Department and a Wire Communications Engineering Department. The Radio Communications Department consists of the former Telecommunications Department of Tientsin University and additional high-level technical personnel selected and assigned to this department by the Ministry of Posts and Telecommunications. The department contains experimental laboratories for: electron and ion tube amplifying equipment; receiving; transmission; and fundamentals of radio. In addition, research is done on and courses are held in the following: electron tubes, ion tubes, electron tube amplifiers, radio receiving equipment, electromagnetic wave broadcasting and antenna engineering, television, radio transmission equipment, and broadcasting.

Posts and Telecommunications Scientific Research Institute (Yu-tien K'o-hsueh Yen-chiu-so) 6755/7193/4430/1331/4282/4496/7108, Peiping—The institute probably is subordinate to the Technical Department of the Ministry of Posts and Telecommunications. The institute contains: a) Experimental Plant; b) Instrument Section; c) Long-Distance Telephone Section; d) Municipal Telephone Section; and e) Telegraph Section.

Shanghai Telecommunications Research Institute (Shang-hai Tien-hsin Yen-chiu-so) 0006/3189/7193/0207/4282/4496/2076/, Shanghai—The institute is concerned with the telecommunications applications of semiconductor devices, microwave communications, and electronics. In April 1957, the institute was to utilize "present telecommunications facilities and personnel in Shanghai."

Southwest Radio Equipment and Materials Plant (Hsi-nan Wu-hsien-tien Ch'i-ts'ai Ch'ang) 6007/0589/3541/4848/7193/0892/2624/1681, Ch'eng-tu—This facility was constructed with Soviet assistance. According to the Chinese, the construction of plant facilities, including the main building, a porcelain producing building and auxiliary buildings, machine placement, water lines, and production organization, were based completely on the most recent Soviet designs. Engineering development is conducted here on capacitors, resistors, and similar components.

Tsinghua University (Ching-hua Ta-hsueh) 3237/5478/1129/1331, Peiping—Circa 1958 the university offered courses in electrical machine manufacturing and electrical materials manufacturing, including electrovacuum techniques. Courses in signal communications, including radio engineering, were also held. The Radio Engineering faculty had a laboratory. A television research section was organized at the university about 1948 in cooperation with the Academy of Sciences; it is used for research by faculty members. The Radio Electronics Department made equipment for industrial television. In 1959 the university included an Electrical Engineering Department, a Radio Electronics Department, and an Automatic Control Department.

Wu-han Geophysical Observatory (Ti-ch'iu Wu-li Kuan-hsiang-t'ai) 0966/3808/3670/3810/6034/6272/5270, near Hankow—The observatory is subordinate to the Wu-han Branch of the AS and is also known as the Institute of Upper Atmosphere Physics. Among the missions of the observ-

FIGURE 71–24. INTERIOR VIEWS OF PEIPING ELECTRON TUBE PLANT

atory is research in upper atmosphere physics for improving radio communications. The observatory contains three divisions: Ionosphere Division; Atmospheric Ozone and Nightglow Division; and Cosmic Ray Division. The Ionosphere Division investigates the physical properties of the ionosphere and their effect on electromagnetic wave propagation.

D. Outstanding personalities

CH'EN Fang-yun (7115/5364/0336), Prof. Dr.—Electronics. Member, Institute of Electronics, AS, since 1956. Member, Scientific Committee, Purple Mountain Astronomical Observatory in 1957. Member of group responsible for radio observation of artificial earth satellites, AS, in 1957. Member, Institute of Physics, AS in 1954. Visited Dresden Technical College, East Germany, April 1957. In April 1958 was co-director with A. P. Molchanov, Academy of Sciences, U.S.S.R., of joint expedition of Soviet and Chinese scientists to observe solar eclipse on Hainan Island. Research: studies of super-short-waves, super-short-wave tubes, supersonics, radioastronomical observations.

CH'ENG Chung-chih (2052/4191/1807)—Electrical engineering, semiconductors and transistors. Member, Semiconductor Research Section, Institute of Physics, AS, 1956. Instructor in semiconductor circuits, Institute of Physics, 1956–57. Member, Transistor Research Center, Peiping, 1956 to at least 1958. Graduate student in electrical engineering at Brooklyn Polytechnic Institute, about 1951–52. Recent publications: "Application of Germanium Amplifier," "Equivalent Circuit and Hybrid Parameters of a Junction Transistor," and "Junction Transistor Convertors."

CH'IEN Lin-chao (6929/5259/3564)—Optics, crystallography, and physics of metals. Head, Crystallography Department and Metallic Physics Department, Institute of Physics, AS. Educated in France. In early 1940's, a designer at Institute of Physics, K'un-ming, which was engaged in making microscopes and devising new methods for making quartz piezoelectric crystals. In 1947 assigned by Chinese Government to attend annual meeting of American Society for Engineering Education, in Minneapolis, and to negotiate with UNRRA for purchase of educational rehabilitation equipment. Technical expert with Chinese delegation to UNESCO General Conference, 2nd Session, held in Mexico City, November 1947. Member, Chinese scientific delegation which visited the Zeiss plant and *Jena Glaswerk Schott Gen. VEB*, both in Jena, June 1951. In 1954, member Editorial Board, *Acta Physica Sinica* (organ of China Physics Society). Member in 1957 of Scientific Committee, Scientific Instruments Center, Academy of Sciences. Believed to be working on germanium single-crystal transistors in 1957. Recent publications; "Characteristics of Glide Caused by Stretching a Scratched Aluminum Single Crystal"; and "Influence of Predeformation at Various Temperatures on Plastic Deformation of Aluminum Single Crystal." Born 1906 at Wushi, Kiangsu province.

FAN Hsin-pi (5400/2450/1732), Dr.—Electrical engineering and electronics. Member, Institute of Computation Techniques, AS, since at least 1956; in charge of institute's Memory Group. Assistant, Electronics Laboratory, National Central University, Nanking, from 1945 to 1948. Employed at Burroughs Research Laboratories, Paoli, Pennsylvania, from 1952 to 1954. Educated at Stanford University in 1949–51. Returned to China in 1954. Visited U.S.S.R. in 1956. Since his return to China has written propagandistic statements and cosigned an open letter to Chinese students in the United States urging their return to China. Recent research: development of ferrite memory cores. Invented a device for controlled switching of electronic beams by means of a magnetic field. Born: 1922.

FENG Ping-ch'uan (7458/4426/6898), Prof. Dr.—Electronics; first class physicist. Dean, Engineering College, Hua Nan University, in Canton, since 1953, Member, Editorial Board, *Acta Physica Sinica*, 1956. Vice chairman, Canton Municipal Committee, Chinese Peoples' Political Conservative Conference during 1956–57. Received D.Sc. degree from Harvard University in 1942. Instructor in electronics, Harvard University, from 1942 to 1945. Returned to China in 1946. Dean, Lingnan University in Canton from 1948 to 1951. Member, Chung Shan University, in Shekp'ai, 1950. Possibly director, Institute of Physics, AS, sometime during 1954. Director, China Physics Society, in 1956. Reportedly anti-Communist who appears pro-Communist for reasons of expediency. Criticized strongly during antirightist campaign for his excessive praise of U.S. attainments in science. Research: radar, characteristics of power tubes, self-excited power oscillators. Born: 1911.

HSIEH Chia-lin (6200/1367/7782), Dr.—Physics, especially electronic accelerators and microwaves. Senior Research Fellow, Institute of Physics, AS, since 1956. Technical supervisor in installation of linear accelerator for electrons for therapeutic purposes at Argonne Cancer Hospital, University of Chicago in 1955. In 1952 taught course in electromagnetic theory at the University of Oregon. Received M.S. from California Institute of Technology in 1948. In 1951 received Ph.D. in physics from Stanford University and did research in Stanford's Microwave Laboratory. Research: radio physics; microwave techniques and linear accelerators. Born: 1920.

HUANG K'un (7806/2492), Dr.—Mathematical physics; director, Laboratory of Semiconductors, AS, since 1956. Director, Department of Physics, Peiping University, since at least 1954. Member, Scientific Committee, Institute of Physics, AS, in 1956 and 1957. Member of Department of Physics, Chemistry, and Mathematics, AS. Won Third Class National Science Award from Academy of Sciences in 1957 for his "Theory of Crystallinity." Received Ph.D. from Bristol University, England in 1946. Attended Third All-Union Mathematical Congress in Moscow in July 1956. Research: crystallinity; solid matter; semiconductors; theory of R-center and the ionic lattice.

KAO Ting-san (7559/7844/0005)—Physics; semiconductors. Associate professor, Physics Department, Northeast People's University, since 1955. Assistant to editor-in-chief, National Research Council, Academy of Sciences, Nanking, from 1941 to 1947. Assistant in Physics Department, National Associated Southwest Universities, from 1942 to 1944. Instructor in physics and mathematics, Wu-hua High School, K'un-ming, from 1944 to 1946. Reader at Physics Department, University of California, Berkeley, in 1948–49, and teaching assistant from 1949 to 1953. Employed at International Rectifier Corporation, Los Angeles, from 1953 to 1955. Member: Physics Society of China; Sigma Xi fraternity. Graduate student at University of California where he had an excellent academic record but "showed so little aptitude for research that after two unsuccessful starts . . . he was dropped as a candidate for the Ph.D. degree." Recent research: in charge of research in manufacture of germanium rectifiers and point-contact germanium triodes; work is probably based on his research in the United States in 1953–55. Born: 1917.

LI Ch'iang (2621/1730)—Telecommunications. Director, Institute of Electronics from 1956 to 1958. Director of the Telecommunications Bureau, Ministry of Posts and Telecommunications from 1949 to 1953; Deputy Director of Foreign Trade since 1952; Trade Counselor with the Chinese Embassy in the U.S.S.R. in 1953; member, Preparatory Committee, Department of Technical Sciences in 1955. In 1949, served on the Preparatory Committee for the 1st All-China Scientists Conference, and in 1959 was the acting chairman of the Sino-Soviet Commission on Scientific and Technical Cooperation. In 1950, Li was a delegate to the International High Frequency Broadcasting Conference held at Florence, Italy, and was the Chief Chinese Delegate to the 5th Session of the Administrative Council of the International Telecommunications Union held in Geneva.

MA Ta-yu (7456/1129/3731), Prof. Dr.—Electronics; the leading acoustics specialist in China. Deputy director, Institute of Electronics, AS, since 1956. Dean, School of Engineering, Peiping University, 1947–52. Associated with Institute of Physics, AS, from about 1954 to 1956. Chief, Secretariat of China Federation of Scientific Societies. Chairman, China Electronics Society. Member: Department of Technical Sciences, AS, and Chinese Communist Party. Studied in United States at UCLA and Harvard. Attended Fourth All-Union Acoustics Conference, held in the U.S.S.R. in 1958. Research: architectural acoustics, underwater equipment, ultrasonics. Born: 1915.

TANG Yu-chi, Dr.—Physical chemistry and crystallography. Staff, Institute of Physics, AS, since 1956. Staff, Department of Chemistry, Peiping University, since 1954. Executive director, China Chemical Society. Received Ph.D. from California Institute of Technology in 1950. Returned to China in 1951 via the Second International Congress of Crystallography in Stockholm, Sweden. Research: growing single sodium potassium tartrate crystals for advanced electronic computers; crystals of sodium chloride and its alkali halide for use in infrared devices; X-ray structural analysis. Born: 1920.

WANG Cheng (3769/6927), Lt. Gen.—Electronics; Communist China's top Party man in telecommunications. Director, Telecommunications Department, People's Liberation Army, from 1953 to 1959. Military Representative to Second National People's Congress in 1959. Chairman, Preparatory Committee, Electronics Society of China from 1956 to 1959. Member, Scientific Planning Committee of the State Council in 1957. Deputy Minister for Posts and Telecommunications from 1949 to 1953. Director, Telecommunications Bureau, People's Revolutionary Military Council from 1949 to 1954. Received Order of August First, First Class, and the Order of Liberation, First Class, during 1955. Accompanied Chou En-lai to Moscow for Sino-Soviet negotiations during August–November 1952. Research: radio and signal communications. Born: 1909.

WANG Shou-wu (3769/1343/2976), Dr.—Semiconductors. Member, Institute of Physics, AS, since 1956. Member, Laboratory of Semiconductors, AS, since 1956. Assistant instructor, Tungchi University, 1941. Student from 1945 to 1949 at Purdue University, where he received Ph.D. degree in 1949. Returned to Communist China in October 1950. On return to China made anti-U.S. statements. Research: transistors, theory of electron-voltaic effect in semiconductors. Born: 1919.

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E. Comment on principal sources

Much of the information in this Section was obtained from open literature and supplemented by official U.S. Government reports. The information is considered generally accurate through mid-1959.

In almost all cases, detailed information is lacking on the electronics research projects now being conducted at various research institutes. Information is especially deficient regarding funds available to the technical ministries for electronics research and development, and detailed and current information in such fields as wire, radio, and microwave communications equipment, navigational aids, electronic countermeasures, infrared, and radar.

72. *Air, Ground, and Naval Weapons*

A. General

1. Capabilities and trends

Communist China's scientific and technical competence is not adequate for the native design and development of modern weapon systems. Chinese capabilities in this field are hampered severely by the lack of adequate facilities and trained scientific manpower. Moreover, the nation lacks the capacity to mass produce foreign-designed systems in sufficient numbers to meet its military requirements. The development of a mature industrial technology that permits the production of these advanced weapon systems is one of the primary objectives of Communist Chinese leaders today. To attain this goal, Chinese efforts have been and continue to be supported strongly by Soviet assistance.

In air weapons, Communist China is totally dependent upon the U.S.S.R. for advanced fighter and bomber aircraft and for guided missiles. Starting with practically no aeronautical design resources this nation has made some progress in developing a native capability to design, develop, and produce low-performance aircraft. Manufacturing experience has been gained in producing the MIG–15 and a trainer version of this aircraft.

In ground weapons, there is no concrete evidence of a long-range armaments research and development program underway in China. Only one significant weapon, a 102-mm field rocket launcher, has shown originality of design and this weapon is now obsolescent.

The Chinese are not doing any significant naval engineering research but are devoting their meager facilities to solving practical problems and to training personnel. The only important achievement that might be credited to the Chinese is a new class ship, the Shanghai class. This ship, with fast patrol-type lines, has recently been sighted in the Chinese Navy. Bearing no resemblance to foreign vessels with the same function, its basic hull may be the result of Chinese design and development.

2. Background and organization

In 1949 the Communist regime assumed control of little or nothing in the way of organized science. Since that time, they have exerted an extensive effort to correct this situation by reorganizing and expanding the Academy of Sciences (*Chung-kuo K'o-hsueh-yuan*), AS, Peiping, and improving education. Weapons development by necessity is based upon this meager background augmented by assistance from foreign countries, primarily the U.S.S.R. The governmental structure, particularly in the administration of science and technology, has some similarities with that of the Soviet Union, but control of science is more centralized in China and the Party is much more dominant in scientific affairs.

Research applicable to weapons development is conducted at academy, educational, industrial, and military institutes. (See FIGURE 72–1 for a glossary of Chinese Communist organizations concerned with air, ground, and naval weapons.) The military forces and their research organizations are subordinate to the Ministry of National Defense (*Kuo-fang Pu*), and the Academy of Sciences to the State Council. The higher educational and major industrial institutes are subordinate respectively to the Ministry of Education (*Chiao-yu Pu*) and to the various industrial ministries. The ministries are in turn subordinate to the State Council which is responsible to the Central Committee of the CCP.

The (State) Scientific and Technological Commission (*K'o-hsueh Chi-shu Wei-yuan-hui*) of the State Council, determines the scientific fields of emphasis in accordance with the overall economic plan. It is responsible for the planning and control of Chinese scientific research (see FIGURE 72–2). FIGURE 72–3 shows the locations of Chinese weapons research and development organizations.

B. Aircraft weapons

1. Capabilities and trends

Chinese capabilities in the development of manned aircraft for military use are confined to those in the support category, mostly light transports and primary trainers, because of the almost nonexistent aeronautical research facilities and the acute shortage of aeronautical scientists.

Although Communist China has no design and development capability in the fighter and bomber fields, valuable experience has been gained in producing the MIG–15 fighter and a trainer version of this aircraft. In the latter case this assembly process began with the Chinese using Soviet-

FIGURE 72–1. GLOSSARY OF CHINESE COMMUNIST ORGANIZATIONS CONCERNED WITH AIR, GROUND, AND NAVAL WEAPONS

Academy of Sciences (*Chung-kuo K'o-hsueh-yuan*), AS, Peiping.
Automobile Plant No. 1 (*Ti-i Ch'i-ch'e Chih-tsao-ch'ang*), Ch'ang-ch'un.
Aviation Materials Research Institute.
Central Design and Construction Office for Shipbuilding, Shanghai.
Chiao-t'ung University (*Chiao-t'ung Ta-hsueh*), Shanghai.
First Ministry of Machine Building (*Ti-i Chi-hsieh Kung-yeh Pu*).
Institute of Automation and Remote Control (*Tzu-tung-hua Chi Yuan-chu-li Ts'ao-tsung Yen-chiu-so*), Peiping.
Institute of Electromechanics (*Chi-hsieh Tien-chi Yen-chiu-so*), AS.
Institute of Electronics (*Tien-tzu-hsueh Yen-chiu-so*), Peiping.
Institute of Mechanics (*Li-hsueh Yen-chiu-so*), Peiping.
Internal Combustion Engine Research Institute, Shanghai.
Ministry of Communications (*Chiao-t'ung Pu*).
Ministry of Education (*Chiao-yu Pu*).
Ministry of National Defense (*Kuo-fang Pu*).
Motor-Vehicle Research Institute, Ch'ang-ch'un.
Nan-ch'ang Aircraft Factory (*Nan-ch'ang Fei-chi Chih-tsao Ch'-ang*), Nan-ch'ang.
Nanking Aviation College, Nanking.
Ninth Bureau of the First Ministry for Machine Building (*Ti-i Chi-hsieh Kung-yeh Pu Ti-chiu Chu*).
Northwest Engineering College (*Hsi-pei Kung-hsueh-yuan*), Sian.
Peiping Aeronautical College (*Pei-ching Hang-k'ung Hsueh-yuan*), Peiping.
Peiping Aircraft Factory (*Pei-ching Fei-chi Chih-tsao Ch'ang*), Peiping.
Products Design Bureau for Commercial and Fishing Vessels of the Central Design and Construction Office for Shipbuilding, Shanghai.
Products Design Bureau for Main and Auxiliary Engines, Installations, and Equipment of the Central Design and Construction Office for Shipbuilding, Shanghai.
Products Design Bureau for Special Purpose Vessels of the Central Design and Construction Office for Shipbuilding, Shanghai.
Scientific Research Institute for Shipbuilding (*Tsao-ch'uan K'o-hsueh Yen-chiu-so*), Shanghai.
Shen-yang Aircraft Factory (*Shen-yang Fei-chi-ch'ang*), Mukden.
Shen-yang Aviation Engineering College, Mukden.
Shipbuilding Engineering Association.
Ship Design Institute of the Ministry of Communications.
(State) Scientific and Technological Commission (*K'o-hsueh Chi-shu Wei-yuan-hui*).
Tractor Research Institute, Peiping.

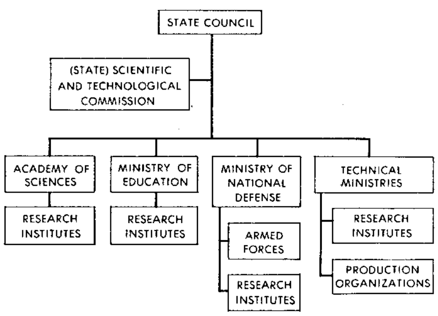

FIGURE 72–2. ORGANIZATION OF CHINESE WEAPONS RESEARCH AND DEVELOPMENT

manufactured components exclusively; however, today it appears that all parts of the trainer version, except possibly the engines, are being manufactured in Communist China. There is evidence that the Communist Chinese are producing MIG–17-type aircraft; it is believed the activity is confined primarily to assembly of Soviet-manufactured components, although the Chinese are probably capable of producing some airframe parts for the MIG–17. Nevertheless, it is felt that the Chinese are still depending to a large extent on the U.S.S.R. for technical advice, for parts to produce fighter aircraft, and for training in the fabrication and operation of these aircraft.

In the bomber field, Communist China is totally dependent on the U.S.S.R. Chinese capability does not extend beyond that of assembly of Soviet components; native development of bomber aircraft is believed beyond present capabilities because of the shortage of engineers, skilled workers, and facilities.

Overall, it appears that Communist China has embarked on a planned program of developing its own native aeronautical capabilities, starting with the low-performance, relatively simple support and trainer-type aircraft.

2. Background and organization

Planning and control of the Chinese aeronautical research and development program follow general lines laid down by the Party and generally supervised by the (State) Scientific and Technological Commission, particularly its Aviation Division. The ministry primarily concerned is the First Ministry of Machine Building, probably in coordination with the Ministry of National Defense. Principal substantive support in planning is provided by the Institute of Mechanics of the Academy of Sciences.

The Chinese Communist had almost no aeronautical talent or facilities in 1949. Since that time a few basic research organizations, schools, and production facilities for aeronautical systems

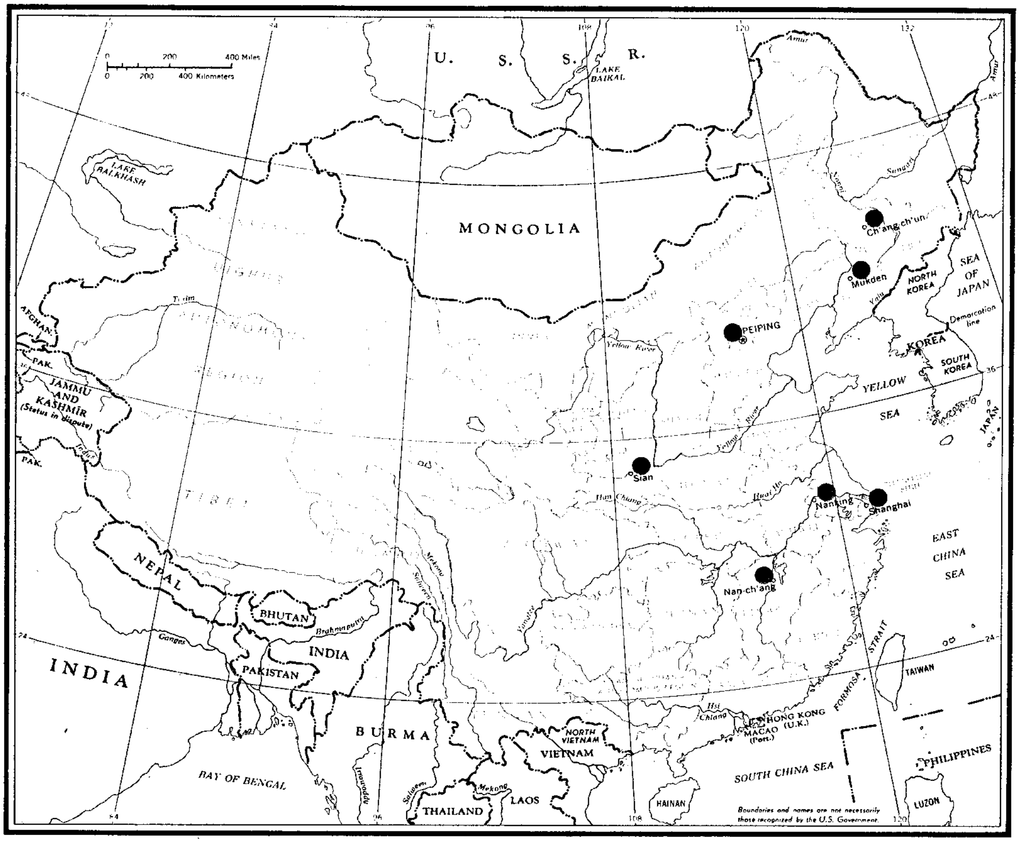

FIGURE 72–3. LOCATIONS OF AIR, GROUND, AND NAVAL WEAPONS ACTIVITIES

LOCATION—SIGNIFICANCE
CH'ANG-CH'UN (43°52'N., 125°21'E.)—Automobile Plant No. 1; Motor-Vehicle Research Institute.
MUKDEN (41°48'N., 123°27'E.)—Shen-yang Aircraft Factory; Shen-yang Aviation Engineering College.
NAN-CH'ANG (28°38'N., 115°56'E.)—Nan-ch'ang Aircraft Factory.
NANKING (32°03'N., 118°47'E.)—Nanking Aviation College.
PEIPING (39°56'N., 116°24'E.)—Academy of Sciences; Institute of Automation and Remote Control; Institute of Electronics; Institute of Mechanics; Peiping Aeronautical College; Peiping Aircraft Factory; Tractor Research Institute.
SHANGHAI (31°14'N., 121°28'E.)—Central Design and Construction Office for Shipbuilding; Chiao-t'ung University; Internal Combustion Engine Research Institute; Scientific Research Institute for Shipbuilding.
SIAN (34°16'N., 108°54'E.)—Northwest Engineering College.

have been established and developed. The curricula of the aeronautical schools, designed to provide senior aviation personnel such as airplane design engineers, engine design engineers, and instrument design engineers, combine formal education with design and limited production. Several low-performance aircraft based on Soviet designs have been produced at these schools. The most important aeronautical schools are the Peiping Aeronautical College (*Pei-ching Hang-k'ung Hsueh-yuan*), Peiping, the Northwest Engineering College (*Hsi-pei Kung-hsueh-yuan*), Sian, the Shen-yang Aviation Engineering College, Mukden, and the Nanking Aviation College, Nanking.

Basic aeronautical research is conducted primarily by institutes under the AS such as the Institute of Mechanics. Applied aeronautical work, other than that done in the aeronautical schools, is limited to the production of Soviet-designed aircraft. Some of the factories producing these aircraft are the Peiping Aircraft Factory (*Pei-ching Fei-chi Chih-tsao Ch'ang*), Peiping, Shen-yang Aircraft Factory (*Shen-yang Fei-chi-ch'ang*), Mukden, and the Nan-ch'ang Aircraft Factory (*Nan-ch'ang Fei-chi Chih-tsao Ch'ang*), Nan-ch'ang.

3. Research and development by field

a. AERODYNAMICS — Chinese capability for aerodynamic research is very limited; the only major facility for this use is the Institute of Mechanics in Peiping. Dr. Ch'ien Hsueh-sen, who supervises the institute, is an internationally recognized authority in the fields of aerodynamics, propulsion, and automatic control. Dr. Ch'ien and other American-educated scientists at the institute form a nucleus of scientific talent capable of advanced aerodynamic research when they are provided with suitable facilities and technical support. There is evidence from published works, however, that considerable attention has been given to mathematical research connected with solving problems in fluid mechanics, aerodynamics, and supersonic flight. Both this institute and the Peiping Aeronautical College now have small, low-speed wind tunnels in operation.

A small amount of aerodynamics research also is conducted at the technical institutes in conjunction with the aeronautics courses. There are few test facilities such as wind tunnels and no outstanding research has been reported in this field.

b. STRUCTURES RESEARCH — The Chinese are doing very little work in structures. Some mathematical research, however, has been applied to problems of the deformation of thin shells and to the theory of plasticity.

c. MATERIALS RESEARCH — Considerable work is being done in the development, production, and application of both ferrous and nonferrous metals. There is little evidence, however, that this work is directly applicable to aircraft development. With the exception of aluminum, the materials for the production of high-performance aircraft and other air weapons are not generally available in China. The Soviet Union is the prime supplier of materials to China, but many materials are furnished only on a limited scale. An Aviation Materials Research Institute has been established in the First Ministry of Machine Building, but little is known of its work.

The Chinese have a very limited ability to produce fuel- and oil-resistant rubbers, moderately high temperature silicone rubbers, and glass-fiber-reinforced plastics.

d. AIRCRAFT DEVELOPMENT — The Chinese have the capability to design and produce low-performance aircraft in limited quantities. The design of modern military aircraft is not within the capability of the Chinese at this time, but Soviet-designed bombers could be assembled. Soviet fighters and transports have been produced; trainers and low-performance transports, similar in design to other bloc aircraft, have also been produced by the Chinese.

Among the more important aircraft produced in China are the MIG–17 and MIG–19 fighters, reportedly produced at the Shen-yang Aircraft Factory (the MIG–17 is being phased out for the MIG–19 (FARMER)); the Soviet designed AN–2 transport, at the Nan-ch'ang Aircraft Factory; and the YAK–18 trainer, at the Peiping Aircraft Factory (see FIGURE 72–4). In addition, light aircraft have been built at the Northwest Engineering College, Sian, and the Peiping Aeronautical College. FIGURE 72–5 shows a seaplane, the Flying Dragon No. 1.

e. AIRCRAFT PROPULSION — Aircraft gas turbine engine development is presently only in the formative stage in China. Although assembly of Soviet VK–1 and VK–1A-type engines has been underway for some time, there is no evidence that the Chinese have conducted any research and development to improve engine performance.

f. AIRCRAFT ARMAMENT — There is little evidence that China is engaging in research and development of aircraft armament. Production of ammunition and machine guns has been reported, but there is no evidence of research and development of airborne fire control or bombing sys-

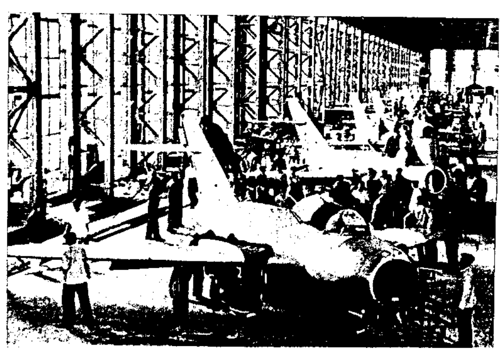

FIGURE 72–4. JET AIRCRAFT ASSEMBLY PLANT AT MUKDEN, 1957

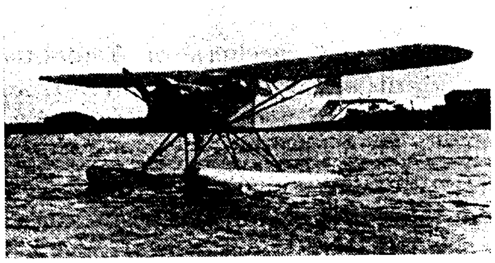

FIGURE 72–5. THE FLYING DRAGON NO. 1

tems. (For information on air-to-air missiles, see Subsection C.)

4. Significant research and development facilities

Institute of Mechanics (*Li-hsueh Yen-chiu-so*), *Peiping*—Director: Ch'ien Hsueh-sen since founding of the institute in 1956. Variant names of the institute are Institute of Dynamics and Institute of Kinetics. The Institute of Mechanics, part of the Institute of Mathematics until 1955–56, is subordinate to the Department of Mathematics, Physics, and Chemistry of the Chinese Academy of Sciences. Major groups of the institute are concerned with hydrodynamics, elasticity, combustion (chemical fluid dynamics), physical-chemical dynamics, plasticity theory, and operations research. Current research activities include both theoretical problems of mechanics and, reportedly, research on propulsion and guided missiles. Specific areas of research are aerodynamics, magnetohydrodynamics, rarefied gases, and allied topics. Certain basic research here reportedly is done at the request of the Ministry of National Defense. The institute also is engaged actively in training research personnel. Equipment includes two small wind tunnels, suitable mainly for the instruction of students and for low-speed aerodynamic studies.

Peiping Aeronautical College (*Pei-ching Hang-k'ung Hsueh-yuan*), *Peiping*—Director: Wu Kuang in 1958. The college, patterned after the Moscow Aviation Institute, was founded in 1952. Its primary function is the training of students in aeronautical engineering and aircraft engine design. There are about 200 graduates each term. The college also serves as a theoretical research facility. A four-engine jet aircraft was designed by the faculty and students here and improvements in the design of a jet engine have been made. In 1958, the school manufactured the Peiping No. 1, a light twin-engine transport. The school has an East German wind tunnel with a reported speed of Mach 1.3.

5. Outstanding personalities

CH'IEN Hsueh-sen (6929/1331/2773),* Dr.—Aeronautical engineering; one of the world's leading aeronautical engineers. Director, Institute of Mechanics, AS, since 1957. Assistant professor, California Institute of Technology from 1943–46 and from 1949 to 1955; Chief Research Analyst, Jet Propulsion Laboratory in Pasadena from 1944 to 1946; professor, Massachusetts Institute of Technology from 1946–49. Returned to China in 1955. Member, Department of Physics, Chemistry, and Mathematics, AS, since 1957, and chairman, Department of Dynamics and Dynamic Engineering, China University of Science and Technology. Chairman, All-China Automation Society since 1957. Awarded AS prize of 10,000 yuan in 1957 for his work on engineering cybernetics. Ch'ien has not participated in any international conferences, but he has made several trips to the U.S.S.R. Member, Chinese Communist Party. Received his Ph.D. from California Institute of Technology, magna cum laude, in 1939. Research in jet and rocket technology. Born: 1909.

CHOU P'ei-yüan (0719/1014/3293)—Theoretical physics, specializing in aerodynamics and fluid mechanics. Vice president and professor of physics, Peiping University; dean, 1952–56. Member, AS. President and director of the board, Chinese Physics Society since 1950; chairman, steering committee since 1952. In 1957, listed as prominent member, possibly vice president, Chinese Mechanics Society. Dean of science, Tsinghua University, 1949; professor of theoretical aerodynamics, 1947. B.S. degree in 1926 and M.S. in 1927 from University of Chicago. Ph.D. from the California Institute of Technology (CIT). Worked with Dr. Theodore von Karman as research fellow at CIT, 1945–47. As a war project fellow at CIT, he was probably active in research on aircraft-carried torpedoes, about 1947. Since 1945, has traveled extensively as a Chinese representative at political and scientific meetings in many countries, including the United Kingdom, Poland, Italy, Hungary, and the U.S.S.R. Reportedly a "fanatical Communist." Born: 1902.

KO T'ing-sui (5514/1656/3606), Dr.—Metallo-physics; metallurgist of world renown for work on internal friction. Deputy director, Institute of Metals, Mukden, since 1954. Professor, Physics Department, Tsinghua University, from at least 1950 to 1953. Member, Department of Physics, Mathematics, and Chemistry, AS. Received an award for work in internal friction and mechanical qualities of metals. Received Ph.D. from University of California, Berkeley, 1943. Member, faculty, University of Chicago. Formerly worked on U.S. Government scientific research projects, and is considered to have done outstanding research on the development of materials for use at high temperatures "such as are needed for aircraft and rocket parts." Returned to China, 1949. Visited Japan in 1955 as a member of Chinese science delegation. Research: spectroscopy, deformation of metals, internal friction, and plasticity. Born: 1913.

WU Chung-hua (0702/0112/5478), Dr.—Mechanics; gas dynamics; internationally known for work on gas turbines. Director, Power Research Laboratory, AS, at Tsinghua University, since 1955 (formerly the Dynamic Engineering Department of Tsinghua University).

* Standard Telegraphic Code (STC) numbers, numerical representations of Chinese characters, are given for the names of those organizations for which Chinese characters are available.

Member, Department of Technical Sciences, AS, since 1957. Assistant and instructor in mechanical engineering, Tsinghua University from 1940 to 1943. Aeronautical research scientist with U.S. National Advisory Committee on Aeronautics from 1949 to 1951. Research supervisor at Brooklyn Polytechnic Institute from 1951 until his return to China in November 1954. Educated at Massachusetts Institute of Technology. Member, Institute of Aeronautical Science, American Rocket Society, and Society of Electrical Engineers. Received award for research on design and heat qualities of gas turbines. Member of the Chinese Scientific and Technological Delegation to Moscow in 1957, and member of the Chinese Delegation to Moscow in 1958 for official negotiation on China's Twelve-Year Plan. Recent research: thermodynamic properties of combustible gases; developed a free-gyrating blade grid applicable to all types of gas turbines; and thermodynamic properties of products of combustion of hydrocarbons with air. Born: 1917.

C. Guided missiles and space

1. Capabilities and trends

The Chinese are believed to be in the theoretical or early planning stages of a missile and space program but there are no indications of development, testing, or production. The country lacks the experienced technical personnel and experimental facilities to design and develop native weapons, and it lacks the necessary manufacturing acumen to mass produce foreign-designed missile systems. As a result, dependence upon the U.S.S.R. for technical and logistic support in establishing a missile capability, is continuing. The extent of this support is not known. Reports of political and military agreements between the U.S.S.R. and Communist China, the voluminous data received since 1956 regarding shipments of Soviet guided missiles to China, and purported Soviet aid in building guided missile launching sites throughout China, ordinarily would indicate extensive support; however, substantiating evidence applies only to the presence of Soviet-furnished air-to-air missiles.

Although there is no evidence of direct Soviet bloc assistance in rocketry and guided-missile research, assistance is being provided in related scientific and technical fields. The Soviets have furnished machine tools, electronic manufacturing and testing equipment, rubber and plastic and metallurgical production and testing equipment. Completed electronic equipment furnished by the U.S.S.R. includes radar.

2. Background and organization

Little is known of the Chinese organization for research and development of guided missiles. It is believed that guided missile development is conducted by the same parent organizations controlling aerodynamic vehicle development, the main difference being the specific institutes and factories at which the work is done. The main institutes associated with guided missile development could be the Institute of Automation and Remote Control (*Tzu-tung-hua Chi Yuan-chu-li Ts'ao-tsung Yen-chiu-so*) at Peiping, and the Institute of Mechanics at Peiping. Some development and production work could be done at the Automobile Plant No. 1 (*Ti-i Ch'i-ch'e Chih-tsao-ch'ang*), Ch'ang-ch'un.

3. Research and development by field

a. GUIDANCE AND CONTROL — There is virtually no evidence of Chinese research and development related to missile guidance and control. One report indicates some theoretical research related to the self-guidance of air-to-air missiles—in particular, to pure pursuit attacks which could be applicable to interceptor-launched missiles. While the Institute of Electronics (*Tien-tzu-hsueh Yen-chiu-so*), Peiping, of the AS appears to have physical facilities to undertake weapon guidance development, and individuals with the necessary knowledge of fundamentals, there is no indication that it has undertaken weapon guidance developments.

b. PROPULSION — The Chinese have only recently begun rocket propulsion research and development and currently depend heavily on technical support from the U.S.S.R. Military rocket research reportedly started in 1954 at the Taiyuan Arsenal, which was initially capable of making only 82- and 132-mm bazooka shells.

It has been reported that a Chinese-produced short-range unguided rocket has been experimentally test fired, as have some atmospheric research rockets. Current practice seems to be continued research to build up Chinese capability for the development of rocket propulsion units to meet future requirements, with dependence for the present on the U.S.S.R. for complete designs of small rockets and perhaps direct shipments of intermediate size rockets. At this time, there is no evidence of Chinese capability in propulsion for anything larger than an unguided tactical rocket. Emphasis reportedly has been on the simpler solid propellant systems.

c. AERODYNAMICS — See Subsection B on aircraft weapons of this NIS.

d. WARHEADS AND FUZES — Information concerning research and development on warheads and fuzing is very limited. One report indicates that the Technical Research Department of the Ministry of National Defense has done research on a photoelectric fuze which incorporates safe separation and self-destruction features. Reportedly, the fuze is to be mass produced, but its application is unknown. A native manufacturing capability exists for 152-mm and 122-mm projectiles and proximity fuzes. Warheads of this size—especially 122-mm—could also be applicable to air-to-air missile development. There is an unconfirmed report that the Chinese have modified and "improved" a Soviet warhead and proximity fuze possibly associated with a surface-to-air missile. For information on nuclear weapons, see SECTION 73 of this NIS.

4. Significant research and development facilities

The following facilities may be associated with the guided missile program.

Institute of Automation and Remote Control (Tzu-tung-hua Chi Yuan-chu-li Ts'ao-tsung Yen-chiu-so), Peiping—Director: Ch'ien Wei-chang. Subordinate to the AS, the institute was founded in 1956. It has departments of Instrument Engineering, Automation Systems, and Computers for control purposes.

Institute of Electronics (Tien-tzu-hsueh Yen-chiu-so), Peiping—Director: Ku Te-huan since 1958. The institute is subordinate to the AS. It has the following scientific departments: 1) transistor electronics; 2) wave propagation; 3) ultrasonics; 4) electroacoustics; 5) electronics instruments; 6) radio (including satellite tracking); 7) microwave; 8) chemistry; 9) electron tubes; and 10) electronics. In addition, there are five workshops. Although the total staff of the institute reportedly numbers about 2,000, there are only 20 senior scientists. Individuals at the institute are believed capable of conducting research on missile guidance and control.

Institute of Mechanics—See Subsection B on aircraft weapons of this NIS.

5. Outstanding personalities

CH'IEN Hsueh-sen—See Subsection B on aircraft weapons of this NIS.

CH'IEN Wei-chang (6929/0251/7022), Prof. Dr.—Mechanics; described as "a good scientist, but not outstanding." Director, Institute of Automation and Remote Control, AS, in 1958. Vice president, Tsinghua University, from 1956 until 1958 (associated with this university since 1949). Deputy director, Institute of Mechanics, from at least 1956 until 1958. Member, Institute of Mathematics, Academy of Sciences, in 1954 and 1955. Member, Secretariat, AS, in 1954. Member: Atomic Energy Utilization Committee, AS; Department of Physics, Mathematics, and Chemistry, AS; Science Development Commission; and Board of Directors of the China Mechanics Society. Awarded a second prize of 5,000 yuan by AS in 1957. In 1956 he was elected to Polish Academy of Sciences. Educated in Canada and the United States. Has attended numerous scientific and political conferences. Has visited India and Burma (1951), the U.S.S.R. (1954), Poland (1955), Belgium (1956), West Germany (1956), and Switzerland (1956). Labeled as a rightist and lost all positions as a result of the rectification movement in 1958. Research: automation, dynamics, and jet propulsion; torsion, numerical analysis, and elasticity. Born: 1912.

D. Ground weapons and equipment

1. Capabilities and trends

China has done practically no research and development work on ground weapons and equipment, but has been content to import and produce Soviet materiel of proven capability. The need to renovate and expand the country's arsenal system and to increase its capacity for the production of heavier and more complex weapons has preempted practically the entire technological effort of the armaments industry. As a result, development work has been restricted to modifying Soviet materiel to meet local requirements.

There has been recent evidence of a Chinese desire to inaugurate a long-range armaments research and development program; however, there is as yet no concrete evidence of the program's implementation, nor an indication of its exact scope.

2. Background and organization

When the Chinese Communists assumed power in 1949, they inherited a sizeable arsenal system that had been established partly by the Chinese Nationalists and partly by the Japanese. Production capabilities, however, were limited to mines, small arms, mountain artillery, and ammunition. During the next decade, the efforts of the armaments industry were directed toward making the country self-sufficient in conventional weapons production by enlarging and re-equipping the arsenal system with Soviet aid and by expanding the range of production.

The aspiration to achieve self-sufficiency in conventional weapons has not been fully realized; the production of heavy artillery and the more complex ordnance equipment remains beyond Chinese competence.

There is as yet no concrete evidence of a serious attempt to implement a long-range armaments research and development program. Nor is it clear whether such a program envisages close Soviet-Chinese cooperation on projects or whether the Chinese desire autonomy in armament design. Since the Soviet Union has supplied China with modern conventional arms of post-World War II design, it is doubtful whether an extensive conventional armament research program is contemplated.

The Academy of Sciences and its subordinate institutes will play a major role in the implementation of any armaments research program. Research and development work, when it occurs, undoubtedly would be undertaken both in the arsenals and in those institutes under the academy's Department of Mathematics, Physics, and Chemistry, and Department of Technical Science.

3. Major research and development by field

Only one significant Chinese Communist weapon—a 102-mm field rocket launcher—has shown originality of design, and this item is now obsolescent. All landmines, small arms, artillery pieces, antiaircraft weapons, general-purpose and armored vehicles, and other combat equipment which are presently produced are of Soviet design, and Chinese innovations have been limited to minor modifications.

4. Significant research and development facilities

In addition to the institutes listed below, the Chinese arsenals also would play an important role in any armament research and development program. For a listing of Chinese Communist arsenals, see CHAPTER VI, SECTION 64, Subsection G, Arms and Ammunition.

Institute of Electromechanics (*Chi-hsieh Tien-chi Yen-chiu-so*), *location unknown*—Sources have linked this organization directly to weapons research and development, but details concerning its functions and internal structure are lacking. Subordination of the institute is unknown; this institute or other institutes of similar name have been reported subordinate to the Ministry of National Defense; to the Department of Technical Science of the AS; and to the First Ministry of Machine Building (*Ti-i Chi-hsieh Kung-yeh Pu*). It is not clear whether these units are one.

Internal Combustion Engine Research Institute, Shanghai—The institute has conducted applied research on diesel and gasoline engines.

Motor-Vehicle Research Institute, Ch'ang-ch'un—Development work on general-purpose vehicles is underway.

Tractor Research Institute, Peiping—All types of tractors and their components have been developed.

E. Naval weapons

1. Capabilities and trends

China ranks well above its Far Eastern neighbors, except Japan, in the capability for research and development of naval weapons, although such capability is still far below that of leading Western nations. At this time Chinese capability is clearly discernible only in the ship and power-plant aspects of naval weapons systems. This is an infant capability resting primarily on Soviet technical assistance and advice. It is most significant, however, that the Chinese are learning by constructing modern marine propulsion plants and modern types of ships, such as Riga class destroyer escorts, W-class submarines, and Kronstadt class subchasers. Capabilities of the nation for research and development are rising and although available information is confusing and scarce, plans for expansion are many and imposing.

At best, the facilities within the country are sorely inadequate by any standards. The greatest problem, however, is the shortage of technical personnel. Virtually all the progress made to date can be attributed to the advice and teaching of some of the Soviet Union's most able engineers and scientists.

2. Background and organization

Prior to 1954, China had practically no research facilities and very few technical personnel working in the field of shipbuilding and naval weapons. About this time, however, an agreement with the U.S.S.R. was made under which the Chinese were furnished technical help and prefabricated components of naval vessels.

Concurrently with the start of the Soviet aid program, a department of shipbuilding was instituted at Chiao-t'ung University (*Chiao-t'ung Ta-hsueh*), Shanghai, and a serious effort was initiated to build research facilities and to train technical personnel. This organization has been expanded recently and is expected to strengthen Chinese research and development capability as it begins to turn out technically educated and qualified personnel.

The exact pattern of organization of China's naval research facilities, design offices, and administrations is not clear. FIGURE 72–6 probably portrays, in general, the present organizations, their facilities, and functions. The Ninth Bureau of the First Ministry for Machine Building (*Ti-i Chi-hsieh Kung-yeh Pu Ti-chiu Chu*) exerts overall governmental control of all aspects of ship research, design, and construction. It is believed also to control the operations of the Scientific Research Institute for Shipbuilding (*Tsao-ch'uan K'o-hsueh Yen-chiu-so*), Shanghai, and the Central Design and Construction Office for Shipbuilding, Shanghai. The existence of a branch or office specifically concerned with research and development of naval weapons is not known. Many of the activities of the above offices would be applicable to naval weapon (hull design and ship propulsion) development; however, in none of the

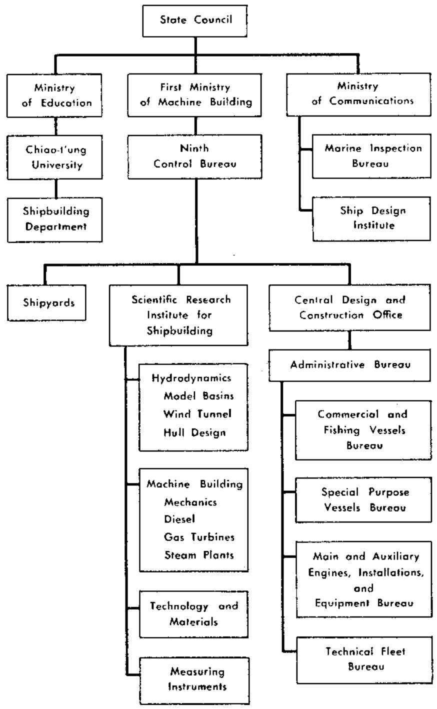

FIGURE 72–6. PROBABLE ORGANIZATION OF CHINESE NAVAL RESEARCH AND DEVELOPMENT

activities is there any mention of ordnance design or construction.

The Scientific Research Institute for Shipbuilding is reportedly destined to become the scientific-technical center of shipbuilding in China. Established in 1951 with a small model basin, it has since expanded rapidly in facilities and stature. Fifty percent of its activities are levied by the Central Design and Construction Office for Shipbuilding; 20% directly by the First Ministry of Machine Building; and the remaining are self-initiated.

The exact functions of the Central Design and Construction Office for Shipbuilding are unknown. Subordinate to this office are five bureaus believed to be referred to as Product Design Bureaus 1–5. One bureau appears to be the administrative control for the other four; one is concerned with commercial and fishing vessels; one with special purpose vessels; one with main and auxiliary engines, installations, and equipment; and one with the technical fleet. No assignment of number with mission can be made. Designs or projects emanating from the individual bureaus are believed to be passed to the Scientific Research Institute for Shipbuilding for trials and/or tests prior to their acceptance and allocation of funding.

The Ministry of Communications (*Chiao-t'ung Pu*) is known to exercise the function of all marine inspection, loadline assignment, etc., and to have a "Ship Design Institute" whose function is probably the preliminary design of merchant and river vessels.

The Chinese Shipbuilding Engineering Association apparently is very similar to the Scientific Technical Society of the Shipbuilding Industry in the U.S.S.R. This society of professional shipbuilding people will facilitate the exchange of scientific and technical information in the Chinese shipbuilding industry and will be a powerful force for standardization in the industry.

3. Major research and development by field

a. HULL DESIGN — Although the Chinese, lacking in qualified personnel, are not producing ship designs embodying original contributions to ship construction, they are designing coastal and river ships of their own by application of Soviet technical information. They also admit to "translating" foreign designs. In all design work they are making every effort to emulate the most modern shipbuilding practice and to utilize the most modern materials. There is evidence, for instance, that they are building plastic boats and even reinforced concrete ships for river service.

Resistance, propulsion, and sea-motion tests currently are being conducted at the model basin of the Scientific Research Institute for Shipbuilding.

There have been several sightings of small, high-speed hydrofoil craft in Chinese waters. External appearance of the craft indicates that they are test or experimental boats. It is likely that these are of Chinese design and construction, achieved by application of Soviet design criteria and experience.

A new class ship, the Shanghai class, with fast patrol-type lines, recently appeared in the Chinese Navy. It bears no resemblance to similar vessels of foreign powers. Although it presents no radical advances in design, and more than likely is propelled by Soviet-designed engines, the basic hull may have been designed and developed by the Chinese.

b. SHIP PROPULSION — As in the field of hull design, China has made no original contributions in research on ship propulsion. Until recently, there was no need for a propulsion plant of greater than several hundred horsepower, and the small engines constructed were based on foreign design. Most ships presently under construction in China are believed to be propelled by machinery of Soviet design and manufacture; however, there is evidence that the Chinese are now applying Soviet technical assistance and training in the actual "trial manufacture" of diesel and steam turbine machinery probably of foreign design. Such experience should strengthen their design capability in this field.

c. ORDNANCE — There is no indication that China has any capability for research and development of surface or underwater ordnance; foreign design is evident throughout.

4. Significant research facilities

Central Design and Construction Office for Shipbuilding, Shanghai—This office controls five design bureaus; little is known of the functions of two of the bureaus. Some information is available on the following bureaus.

The Products Design Bureau for Commercial and Fishing Vessels is concerned with the design and associated activities of merchant ships and fishing vessels. Recent projects have been a 10,000-ton freighter and an 18,000-ton tanker presently under construction. These ships are believed to be of Soviet design. The Products Design Bureau for Special Purpose Vessels is believed to handle design and associated activities of naval vessels. The new Shanghai class, with fast patrol-type lines, may be a result of efforts of this office. The Products Design Bureau for Main and Auxiliary Engines, Installations, and Equipment controls design and construction of machinery and associated equipment. Present activities include construction of diesel engines of 1,800–2,300 horsepower, and "trial manufacture" of diesel engines up to 8,800 horsepower. Basic designs are believed to be foreign, and the bureau may control merely the assembly of foreign-supplied machinery parts. The bureau also is concerned with the standardization of shipbuilding equipment.

Chiao-t'ung University (Chiao-t'ung Ta-hsueh), Shanghai—The Shipbuilding Department here, believed to be patterned after the Leningrad Shipbuilding Institute in the U.S.S.R., has recently been expanded. Among the facilities are seventeen laboratories and a small model basin equipped with German instrumentation. The model basin probably combines instructional efforts with routine ship resistance and propulsion studies. The technical qualifications of the personnel are not available, but it is believed this institution will make significant contributions in the near future.

Scientific Research Institute for Shipbuilding (Tsao-ch'uan K'o-hsueh Yen-chiu-so), Shanghai—Director: Tao Hsi-keng. The institute is subdivided into four units: a Hydrodynamics Department, a Machine Building Department, a Department of Technology and Study of Materials, and a Department of Measuring Instruments. The Hydrodynamics Department has a small (230-foot-long) model basin, a cavitation tank for propeller research, an open maneuvering basin for determining the turning characteristics of vessels, and a low-speed wind tunnel. Qualified European observers report that the instrumentation of these installations is of indifferent quality. Construction of a new, large model basin in the suburbs of Shanghai is planned, but progress to date is unknown. The Machine Building Department is equipped with test stands for steam engines and diesel engines up to 150 horsepower. Larger equipment is under construction. General projects underway in the Department of Technology and Study of Materials are acetylene cutting, construction of concrete hulls, fireproof impregnation of wood, and the uses of laminated wood. Antiquated facilities and the lack of experienced technical personnel are hampering all operations of the institute.

5. Outstanding personalities

CHEN Hu-song—Chairman, Shipbuilding Engineering Association.

CH'ENG Wang—Shipbuilding. Chairman, Preparatory Committee, Shipbuilding Engineering Association, 1956 to 1959. Bureau Chief, Ninth Control Bureau, First Ministry of Machine Building, 1957. Deputy Chief, Shipbuilding Industry Administration, First Ministry of Machine Building, 1956. Member, First Committee, Shanghai Municipal Branch, All-China Federation of Scientific Societies in 1954. Deputy director, Heavy Industry Department, Finance and Economic Takeover Committee, Shanghai Military Control Commission, 1949 to 1950. Research: 5,400-horsepower diesel engine.

CHIANG Wen-chung—Deputy director, Scientific Research Institute for Shipbuilding.

TAO Hsi-keng—Director, Scientific Research Institute for Shipbuilding.

F. Comments on principal sources

The information in this Section was obtained from classified U.S. Government reports and, in many instances, from unsubstantiated open literature. Information on personalities rarely is reported, and biographic data are extremely scarce. In some instances the language barrier made identification of personnel impossible. More information is needed on all aspects of weapons research activities.

73. Atomic Energy

A. General

1. Capabilities and trends

Communist China has a moderate program underway for developing nuclear energy for economic uses, and for conducting basic nuclear research. The country's program is based primarily on guidance and assistance received from the U.S.S.R. Little is known of the military applications of the Chinese nuclear energy program. Several high-ranking Chinese Communist officials have stated that China will be able to produce an atomic bomb in the "not too distant future." Evidence indicates that Communist China is mining uranium ore, and recently it may have acquired a capability to produce uranium metal. As a result, Communist China is developing the industrial base in atomic energy that would permit the country to produce fissionable materials in the future.

The Chinese Communists have concluded several scientific cooperation agreements with the U.S.S.R. and with countries of the Soviet bloc. The most significant of these has been the Sino-Soviet Nuclear Energy Agreement of 1955. Communist China is also a member of the Joint Institute for Nuclear Research (JINR) at Dubna, U.S.S.R., which is composed of representatives of the twelve Communist bloc countries.

Under the terms of the 1955 Sino-Soviet agreement, Communist China has received a 7.5–10 megawatt (mw.) research reactor and a 25 million electron volt (Mev.) cyclotron. Unconfirmed reports state that a 15-mw. research reactor and a 50-Mev. cyclotron are to be constructed under the Second Five Year Plan (1958–62) and that the U.S.S.R. would assist in the construction of two nuclear power stations by 1962, each with an electric power capacity of 150 mw. No confirmed information is available, however, regarding specific Chinese plans to procure either additional research or power reactors.

While a number of institutions are conducting research for the Chinese nuclear energy program, the principal organization is the Institute of Atomic Energy (*Yuan-tzu-neng Yen-chiu-so*), IAE, Peiping, of the Academy of Sciences (*Chung-kuo K'o-hsueh-yuan*), AS, Peiping, which uses the research reactor and cyclotron received from the U.S.S.R. to conduct a moderate research program. The Chinese have constructed the equipment used by the other nuclear research institutes. See FIGURE 73–1 for the locations of atomic energy research and development activities underway in Communist China.

Very little information is available concerning the financial support of the nuclear energy program, although reports indicate that facilities, such as the IAE, have sufficient funds to purchase all needed materials and equipment. The greatest handicap in the nuclear energy program has been the lack of qualified research personnel. Although China does possess a small core of highly qualified scientists—most of whom received their training in the United States, United Kingdom, France, or Germany—their research efforts are restricted by administrative duties and training responsibilities imposed upon them. In order to expand and accelerate the training of additional personnel, China has established the Chinese University of Science and Technology (*Chung-kuo K'o-hsueh Chi-shu Ta-hsueh*), Peiping. The country also sends students to the U.S.S.R. and the satellite countries for training.

2. Background and organization

Promotion of science was an announced policy of the new regime after the Communists assumed control of the mainland in 1949. It is believed that nuclear physics and nuclear energy were considered of priority interest. The new regime set up the Chinese Academy of Sciences in November 1949, with 15 to 20 institutes, by reorganizing and amalgamating the various institutes or laboratories of the Nationalist *Academia Sinica*, Nanking, and the National Academy in Peiping. Nuclear energy studies were assigned priority at the new academy's Institute of Modern Physics; however, the Communists have stated that the research program of this institute did not get underway until 1953. The Chinese Communists looked to the U.S.S.R. for assistance and probably made known their interest at a very early date. In March 1954 the Chinese announced their intention of asking the Soviet Union for help in setting up an atomic energy program. A Sino-Soviet Nuclear Energy Agreement was finally consummated in April 1955, an agreement similar to ones made by the Soviet Union with several other bloc countries. Soon thereafter, Chinese Communist

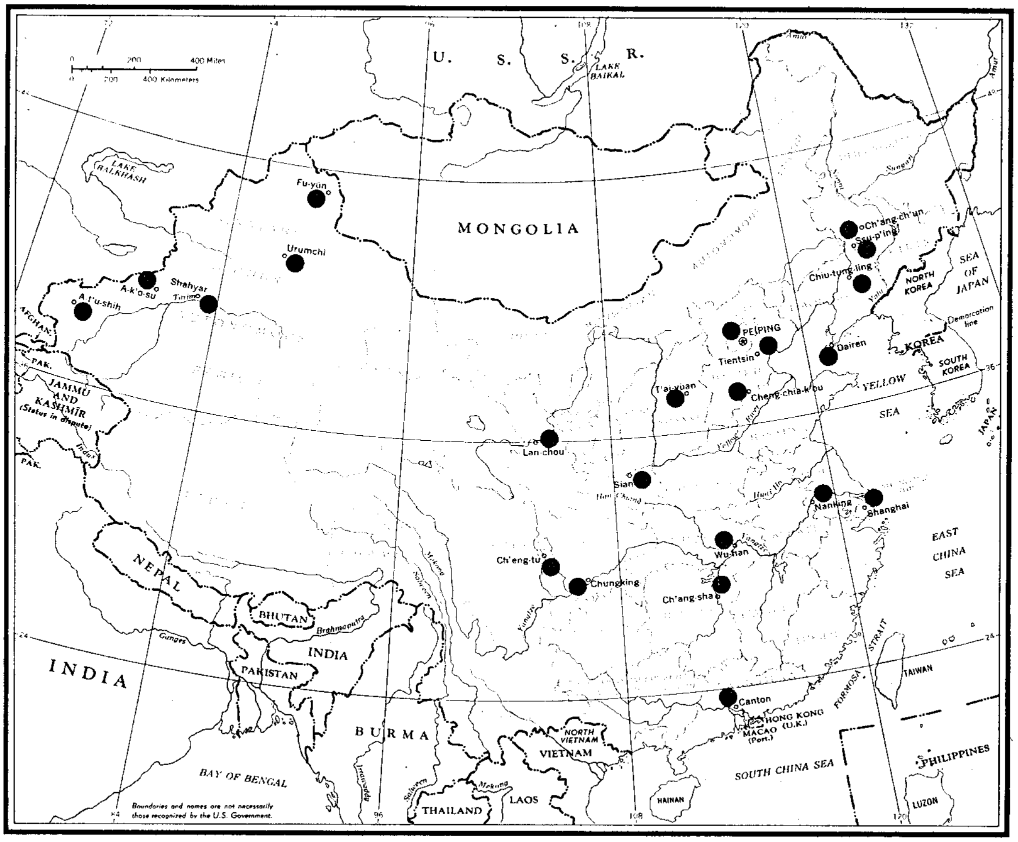

FIGURE 73–1. LOCATIONS OF ATOMIC ENERGY RESEARCH AND DEVELOPMENT ACTIVITIES

LOCATION, BY PROVINCE—SIGNIFICANCE

HOPEH

CHENG-CHIA-K'OU (37°20'N., 115°57'E.)—Alleged atomic energy plant.

PEIPING (Pei-p'ing) (39°56'N., 116°24'E.)—Chinese Academy of Agricultural Sciences, Laboratory for the Use of Atomic Energy; Peiping University, Department of Nuclear Physics; Tsinghua University, Department of Nuclear Physics; Chinese University of Science and Technology; training class for use of radioactive isotopes in medicine; Chinese Academy of Medical Sciences (radioactive isotope research); Institute of Atomic Energy; Institute of Geology; Institute of Physics, AS.

TIENTSIN (T'ien-ching) (39°08'N., 117°12'E.)—Tientsin University, Department of Nuclear Physics; Nankai University, Department of Nuclear Physics; training class for use of radioactive isotopes in medicine.

HUNAN

CH'ANG-SHA (28°12'N., 112°58'E.)—Training class for use of radioactive isotopes in medicine.

HUPEH

WU-HAN (30°34'N., 114°13'E.)—Central China College of Engineering, Department of Nuclear Engineering; Atomic Energy Research Institute.

LOCATION, BY PROVINCE—SIGNIFICANCE

KANSU

LAN-CHOU (36°03'N., 103°41'E.)—Atomic powerplant allegedly being constructed.

KIANGSU

NANKING (Nan-ching) (32°03'N., 118°47'E.)—Section on use of radioactive isotopes in medicine.

SHANGHAI (31°14'N., 121°28'E.)—Training class for use of radioactive isotopes in medicine.

KIRIN

CH'ANG-CH'UN (43°52'N., 125°21'E.)—Branch of the Institute of Geology, AS, for research on uranium ores.

SSU-P'ING (43°10'N., 124°20'E.)—Alleged construction of reactor.

KWANGTUNG

CANTON (Kuang-chou) (23°07'N., 113°15'E.)—Nuclear Radiation Research Section, Canton Branch, AS; training class for use of radioactive isotopes in medicine; Chungshan University, Department of Nuclear Physics.

LIAONING

CHIU-TUNG-LING (41°50'N., 123°31'E.)—Alleged construction site of nuclear energy plant.

DAIREN (Ta-lien) (38°55'N., 121°39'E.)—Institute of Petroleum.

FIGURE 73–1 (*Continued*)

LOCATION, BY PROVINCE—SIGNIFICANCE
SHANSI
T'AI-YÜAN (37°52′N., 112°33′E.)—Alleged site of atomic pile.
SHENSI
SIAN (Hsi-an) (34°16′N., 108°54′E.)—Chiao-tung University, Department of Nuclear Physics; Atomic Energy Research Center; training class for use of radioactive isotopes in medicine.
SINKIANG
A-K'O-SU (40°28′N., 80°52′E.)—Mining and Technological School.
A-T'U-SHIH (39°36′N., 75°50′E.)—Alleged atomic powerplant with heavy water plant.
SINKIANG (*Continued*):
FU-YÜN (47°13′N., 89°39′E.)—Alleged atomic energy plant.
SHAHYAR (41°15′N., 82°50′E.)—Alleged construction of atomic reactor and atomic test plant.
URUMCHI (43°48′N., 87°35′E.)—Headquarters of uranium mining for Sinkiang Province; alleged reactor; uranium ore processing plant.
SZECHWAN
CH'ENG-TU (30°40′N., 104°04′E.)—Szechwan University, Department of Nuclear Physics; training class for use of radioactive isotopes in medicine.
CHUNGKING (Ch'ung-ch'ing) (29°34′N., 106°35′E.)—Southwest Normal College, Department of Nuclear Physics; training class for use of radioactive isotopes in medicine.

studies in nuclear physics and energy probably commenced to take on the beginnings of a systematized program.

In June 1955, the AS was reorganized to concentrate research in 12 fields, the leading field to be nuclear physics. In July 1955, the Academy of Sciences announced a research and development program in connection with the regime's First Five Year Plan (1953–57). Utilization of nuclear energy was designated the first of the 12 broad fields to receive concerted effort. The priority position of nuclear energy was reemphasized in 1956, when the Twelve Year Plan of Science Development (1956–67) was established as a basis for directing the regime's entire research and development effort—nuclear energy again headed the list of the 12 priority fields set forth in the plan.

The present nuclear energy research and development program is controlled and directed by two main bodies, the Chinese Academy of Sciences and the Scientific and Technological Commission. See FIGURE 73–2, which shows the organization of the nuclear energy program.

The Chinese Academy of Sciences is the chief organ for research in Communist China. Reportedly, the academy does planning in conjunction with the Academy of Sciences, U.S.S.R., and has received considerable assistance in implementing its research program. As of March 1959, the academy was believed to be operating 41 nuclear energy laboratories. The most important research in nuclear energy is carried out by the Institute of Atomic Energy (see FIGURE 73–3). Other institutes which are connected with the nuclear energy program are the Institute of Physics (*Wu-li Yen-chiu-so*), AS, Peiping; the Institute of Geology (*Ti-chih Yen-chiu-so*), Peiping; the Institute of Mathematics (*Shu-hsueh Yen-chiu-so*), AS, Peiping; and the Institute of Chemistry (*Hua-hsueh Yen-chiu-so*), AS, Peiping.

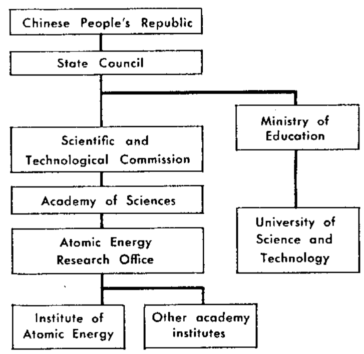

FIGURE 73–2. ORGANIZATION OF THE CHINESE COMMUNIST NUCLEAR ENERGY PROGRAM

The Scientific and Technological Commission is the most powerful organization for controlling scientific research in Communist China. It was formed, in 1958, by the merger of the Scientific Planning Committee and the State Technological Commission. It ensures close cooperation in the coordination of research between the AS and other research organizations. The commission has concentrated on expanding and enlarging existing organizations, increasing research, and training young scientists in atomic energy.

A broader program of nuclear research was begun during 1955–57. The goals of scientific and nuclear policy were clarified; local resources and capacities were surveyed; the necessary steps were taken toward setting up a nuclear research organization; and certain basic research projects in nuclear science and technology were begun.

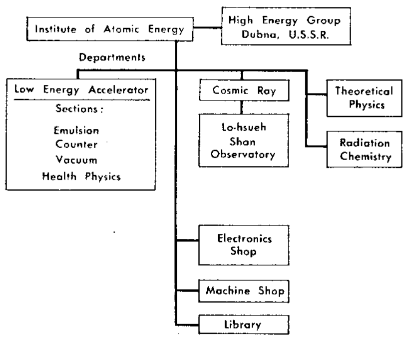

FIGURE 73–3. ORGANIZATION OF THE INSTITUTE OF ATOMIC ENERGY

A Sino-Soviet Nuclear Energy Agreement was signed in 1955, providing for the establishment of a Sino-Soviet Commission for Scientific and Technical Cooperation. Under its terms, the U.S.S.R. agreed to: 1) provide an experimental heavy water moderated research reactor with thermal capacity of 7.5 to 10 mw., and a 25-Mev. cyclotron, and render scientific and technical aid in building, assembling, adjusting, and starting the nuclear reactor and cyclotron, as well as design the scientific and experimental installation to house these facilities; 2) supply the Chinese with fissionable and other materials for the reactor and for carrying out research in nuclear physics; 3) train Chinese specialists in nuclear physics in the U.S.S.R.; and 4) supply Soviet specialists to work in China.

The Soviet research reactor and cyclotron were constructed at the Institute of Modern Physics, now the Institute of Atomic Energy (IAE). When these became operational in mid-1958, the Chinese Communist nuclear energy program was significantly accelerated. On 18 January 1958, following a visit to Moscow during the preceding year of a scientific delegation led by Kuo Mo-jo, president of the AS, a Sino-Soviet Scientific and Technical Agreement covering the years 1958–62 was signed; however, details of this treaty still are not known.

The Chinese Communist nuclear research program is also being assisted by its membership in the JINR, Dubna, U.S.S.R. The country shares 20% of the financial cost of the institute, a sum exceeded only by that of the Soviet Union.

3. Financing

There is little information on which to base a detailed analysis of the financing of the Chinese nuclear energy program; however, several reports have indicated that, due to its high priority, funds available to carry on the program are relatively unlimited. In 1955, according to an agreement between the U.S.S.R. and Communist China, the Chinese Communist government was to allocate 100,000 JMP* for the development of China's nuclear energy program, and the U.S.S.R. was to defray expenses in excess of the Chinese contribution; however, in 1956, reportedly the budget for the IAE alone amounted to 2,000,000 JMP. Although actual expenditures for the nuclear energy program are unknown, an almost 9-fold increase in state expenditures for scientific research was noted between 1955 and 1957, while the 1958 budget for research increased by one-third over that for 1957. It is not unreasonable to suspect that expenditures for nuclear energy research were also significantly increased.

4. Manpower and training

Chinese Communist scientists are, in large measure, subject to stringent control by the Communist Party. Notably excepted are China's nuclear scientists who have, to a great extent, escaped regimentation and thought control, and are given relative freedom in fulfilling their research assignments. They generally receive better pay, superior food, clothing quarters, and more amenities than do scientists in other fields.

Since 1958, particularly, considerably increasing emphasis has been placed on training scientific personnel. The establishment in 1958 of the Chinese University of Science and Technology was undertaken to alleviate the shortage of trained scientific personnel, and offers training in nuclear physics and engineering along with 12 other subjects. Also in that year, the AS assumed responsibility for the overall training program of young scientists. Under the training program of the academy, students are to be sent to the Soviet Union, as well as to bloc countries, for training; however, these training programs are to be limited only to graduate students or to very advanced undergraduate students. Nevertheless, the shortage in quantity as well as quality of trained scientific personnel persists. Consequently, the nuclear energy research institutes

* *Jen Min P'iao*—designation of Chinese Communist currency. The official rate of exchange with U.S. currency is 2.34 JMP to US$1.00; the black market rate of exchange, as of January 1960, was 5.70 JMP per US$1.00.

are permitted very little selection in the choice of graduates.

China's plan to promote nuclear science at each of the country's major universities is becoming increasingly evident. Faculty and students of various universities have built numerous items of equipment useful in an atomic energy program, such as the 1-Mev. cyclotron at the Physics Department of Southwest Normal College (*Hsi-nan Shih-fan Hsueh-yuan*), Chungking; the 2-Mev. cyclotron at Tientsin University (*T'ien-ching Ta-hsueh*), Tientsin; a 10-Mev. induction-electron accelerator at the Central China Engineering Institute (*Hua-chung Kung-hsueh-yuan*), and a 5-Mev. induction-electron synchrotron at Tsinghua University (*Ching-hua Ta-hsueh*), Peiping.

Despite some progress, the nuclear energy program suffers from a shortage of capable scientists and technicians. Although the country has a core of highly competent, Western-trained scientists—comparable in many instances with other leading scientists throughout the world—their effectiveness in forwarding the nuclear energy program is hampered by utilizing part of their time to train other personnel. Moreover, some of these scientists hold several positions simultaneously, thus reducing the amount of time they can devote to research.

B. Major research and development

The major research and development effort of the Chinese Communist nuclear energy program centers around the IAE's two locations near Peiping. The facility about 20 miles southwest of Peiping (see FIGURE 73–4) houses the Soviet-supplied research reactor and 25-Mev. cyclotron (see FIGURES 73–5 and 73–6). The reactor uses a 2%-enriched uranium fuel and heavy water as a moderator, and was designed for a power output of 7.5 to 10 mw. (thermal capacity), and a flux of 10^{13} neutrons per square centimeter per second. The other location, northwest of the walled city of Peiping in the university sector, is concerned mainly with theoretical studies in nuclear physics and with low energy acceleration. Two accelerators, both built by the Chinese, are in use at this locale; one, a 2.5-Mev. electrostatic, proton accelerator, and the other, a 0.75-Mev. Van de Graaff accelerator. (See also SECTION 76 of this NIS for additional related information on this subject.) For a listing of major items of equipment for nuclear research in China, see FIGURE 73–7.

FIGURE 73–4. RESEARCH REACTOR AND CYCLOTRON BUILDING OF THE INSTITUTE OF ATOMIC ENERGY, PEIPING, 1958

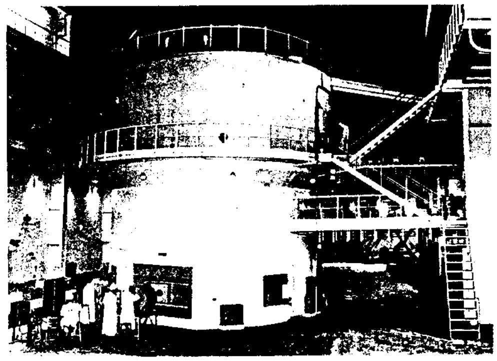

FIGURE 73–5. RESEARCH REACTOR AT THE INSTITUTE OF ATOMIC ENERGY, PEIPING, 1958

Through the installation, operation, and design of these reactors, cyclotrons, and accelerators, considerable opportunity has been afforded for the training of young scientists, and for doing research in nuclear physics, radioactive chemistry, isotope production, and radioactive biology. Chinese-designed spectrographs, used in conjunction with the reactors and cyclotrons, have permitted research efforts on energy spectrums, nuclear reactions and fission physics, and work on the nuclear structure of light atomic nuclei. Chinese physicists apparently have devoted considerable effort toward the development of nuclear radiation detectors and associated electronics. High grade nuclear emulsions and good quality neutron counters have been designed and produced. Some additional work has been done on research, manufacture and improvement of scintillating crystals, ionization chambers, magnetrons, photoelectric multipliers and special electronic tubes for cloud chambers (see FIGURE 73–8 for examples of electronic equipment). More recently, the Chinese have been studying multi-pulse analyzers and milli-microsecond pulse techniques, which would imply future work in the relatively sophisticated field of neutron time-of-flight studies.

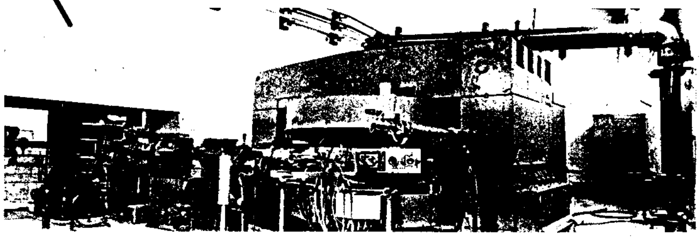

FIGURE 73–6. THE INSTITUTE OF ATOMIC ENERGY'S 25-MEV. CYCLOTRON, 1958

FIGURE 73–7. MAJOR NUCLEAR PHYSICS RESEARCH EQUIPMENT, COMMUNIST CHINA

LOCATION	RESEARCH FACILITY	EQUIPMENT	RATING	REMARKS
Canton	Chung-shun University	Accelerator	*na*	Rotary.
Ch'eng-tu	Szechwan University	Cyclotron	0.06 Mev	
Chungking	Southwest Normal College	*do*	1 Mev	
Dairen	Institute of Petroleum, AS	Accelerator	2 Mev	Van de Graaff.
Peiping	Institute of Atomic Energy, AS	*do*	0.75 Mev	Van de Graaff.
		do	2.5 Mev	Electrostatic, proton.
		Cyclotron	25 Mev	Alpha particle.
		Reactor	7.5–10 MW	Soviet supplied.
	Peiping University	Accelerator	0.7 Mev	Electrostatic.
		do	30 Mev	Induction electron.
	Tsinghua University	Reactor	2 MW	
		Synchrotron	5 Mev	Induction electron.
Sian	Chiao-tung University	Accelerator	1.5 Mev	Electrostatic.
Tientsin	Nankai University	*do*	2 Mev	Electrostatic.
		Reactor	3 watt	
	Tientsin University	Cyclotron	2 Mev	Proton.
Wu-han	Central China Engineering Institute	Accelerator	10 Mev	Induction electron.
	Wu-han Atomic Energy Research Institute	*do*	2 Mev	

na Data not available.

A small group of nuclear physicists at the IAE are doing theoretical research, which is similar to that conducted in a number of countries and includes calculations of energy levels, utilizing the shell-model concept; interactions of nucleons; and characteristics of fundamental nuclear particles.

Nuclear chemistry is being conducted in a number of institutes of the AS. The IAE is mainly concerned in this field with the production of a number of radioactive isotopes in the reactor, and with the separation of stable isotopes using the ion exchange method. Other AS institutes are conducting studies on reactor corrosion problems, uranium and thorium chemistry and the separation of rare-earths. In 1957, it was reported that Communist Chinese scientists had obtained pure uranium and thorium on a laboratory scale.

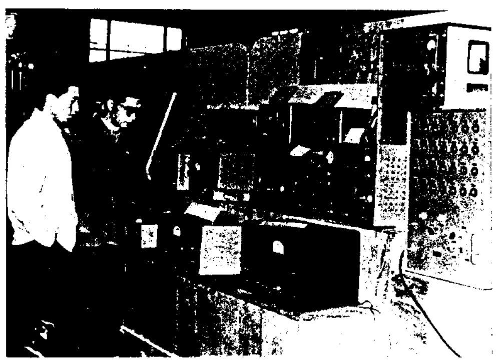

FIGURE 73–8. ELECTRONIC EQUIPMENT CONSTRUCTED BY THE CHINESE FOR USE IN NUCLEAR ENERGY RESEARCH, PEIPING, 1958

C. Sources and production of basic materials

Little or no uranium mining and only a very limited amount of prospecting for uranium minerals were carried on by the Chinese prior to the Japanese occupation of China. Under the Japanese, prospecting activity was increased and some actual mining was done on a small scale. Since 1949, there has been firm evidence of joint Soviet-Chinese exploration of Chinese uranium resources. In March 1950, a Sino-Soviet Non-Ferrous and Rare Metals Company was established with headquarters at Urumchi, for the exploration and exploitation of Chinese minerals, including uranium resources in Sinkiang province. Three years after commencing operations, the company reportedly was producing six varieties of

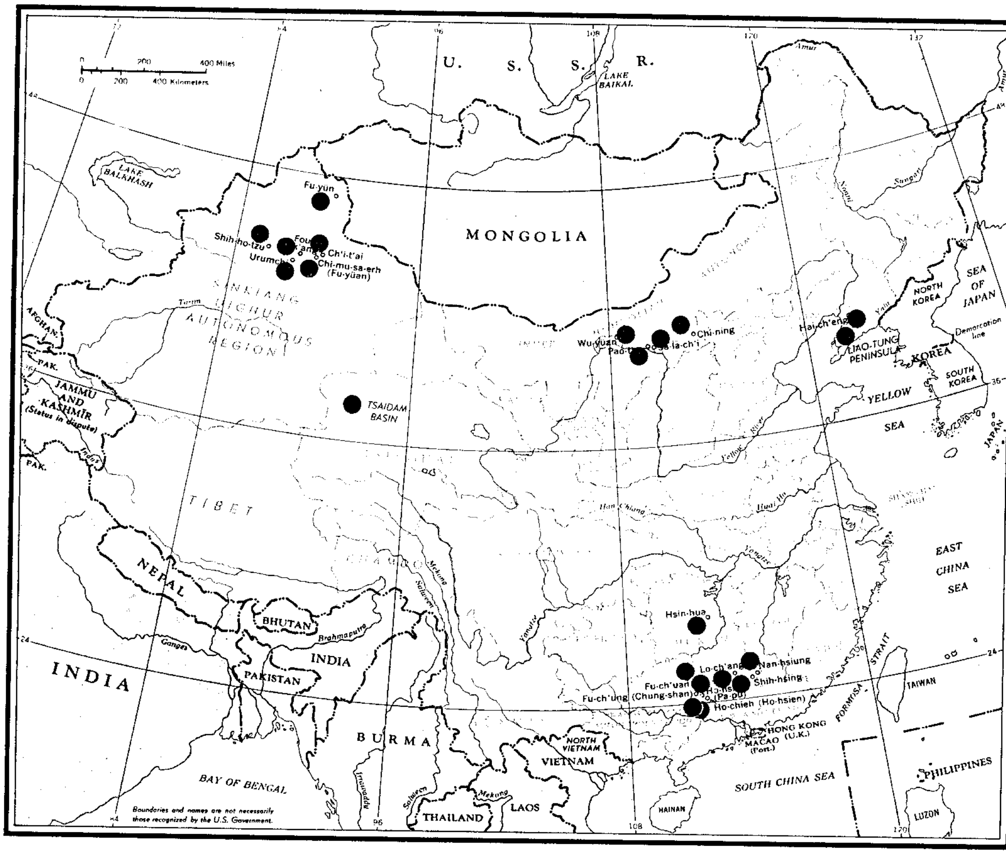

FIGURE 73–9. REPORTED URANIUM DEPOSITS, COMMUNIST CHINA

LOCATION, BY PROVINCE	LOCATION, BY PROVINCE
HUNAN	KWANGTUNG (*Continued*)
HSIN-HUA (27°45′N., 111°18′E.)	NAN-HSIUNG (25°07′N., 114°18′E.)
INNER MONGOLIAN AUTONOMOUS REGION	SHIH-HSING (24°57′N., 114°04′E.)
CHI-NING (40°57′N., 113°02′E.)	LIAONING
PAO-T'OU (40°36′N., 110°03′E.)	HAI-CH'ENG DISTRICT (40°52′N., 122°45′E.)
SA-LA-CH'I (40°33′N., 110°30′E.)	LIAO-TUNG PENINSULA (40°00′N., 122°20′E.)
WU-YUAN (41°08′N., 108°21′E.)	SINKIANG
KWANGSI	CHI-MU-SA-ERH* (Fu-yuan) (43°59′N., 89°04′E.)
FU-CH'UAN (24°50′N., 111°16′E.)	CH'I-T'AI (44°01′N., 89°28′E.)
FU-CHUNG* (Chung-shan) (24°32′N., 111°18′E.)	FOU-K'ANG* (Fu-k'ang) (44°10′N., 87°59′E.)
HO-CHIEH* (Ho-hsien) (24°20′N., 111°39′E.)	FU-YUN (47°13′N., 89°39′E.)
HO-HSIEN* (Pa-pu) (24°25′N., 111°31′E.)	SHIH-HO-TZU (44°18′N., 86°02′E.)
KWANGTUNG	URUMCHI (Ti-hua) (43°48′N., 87°35′E.)
LO-CH'ANG (25°08′N., 113°20′E.)	TSINGHAI
	TSAIDAM (Ch'ai-ta-mu P'en-ti) BASIN (37°00′N., 93°00′E.)

* The names of these places recently have been changed.

uranium ores, and using 3,000 technical personnel and skilled workers. At this time, it was also reported that an ore concentration plant has been constructed, the location of which was subsequently reported to be a short distance southwest of Urumchi. It was further reported at this time, that the company was operating a mining and technological school at A-k'o-su basin.

Particularly after 1955, increased prospecting activity was noted in numerous areas of China, in addition to Sinkiang province. Numerous reports of uranium deposits exist, but there is little information upon which to evaluate them. There appear to be at least five major areas in which the occurrence of uranium has been confirmed or is highly probable (see the map, FIGURE 73–9, which shows specific sites within these areas): 1) Inner Mongolia, particularly in the vicinity of the Yellow River (Huang Ho); 2) Liaoning province in the Hai-ch'eng district; 3) Sinkiang province, in an area following in general the trend of the Tien Shan system; 4) south-central China, including part of Hunan, Kwangsi and Kwangtung provinces; and 5) Tsinghai province in the Tsaidam Basin (Ch'ai-ta-mu P'en-ti).

Although uranium deposits are known to exist at various sites throughout China, very few actual mining sites are known. The area of greatest uranium potential is believed to be Sinkiang province, where mining has been carried out for the past ten years. There were reportedly three mines within 13 miles of Fu-yun, and one of these is said to have produced 1,200 metric tons of uranium ore. The Chinese are also believed to be working two uranium deposits in Liaoning province, both located in the Hai-ch'eng district.

Thorium deposits similarly have been reported at various sites in China, but the most likely areas appear to be in the Tsaidam Basin in Tsinghai province, Hsin-hua in Hunan province, and near Pao-t'ou in Inner Mongolia.

Information is insufficient to permit an accurate estimate of present production of uranium, but it is believed that sufficient ores are mined annually from which several hundred tons of uranium metal per year can be derived. It is believed that the uranium mined in China is for supply of the Chinese nuclear energy program and is not for shipment to the U.S.S.R.

D. Fissionable materials

The Chinese Communists probably have initiated processing ores into uranium metal. We do not believe that they are currently producing U–235 or plutonium, but facilities for the production of these isotopes may well be under construction.

The enriched uranium needed to fuel the Peiping reactor is supplied by the U.S.S.R. under the terms of the 1955 Sino-Soviet Nuclear Energy Agreement, and the reactor is capable of producing only very small amounts of plutonium. Small quantities of plutonium, uranium-235 and uranium-233 in pure form for research purposes can be obtained from the U.S.S.R. under terms of the 1955 agreement.

E. Applications of nuclear energy

In February 1955, a committee of seven Chinese Communist scientists formulated plans for wider applications of nuclear energy. Previously, little had been accomplished when compared with the rather significant progress in the years that followed. The application of nuclear energy now extends to industrial, agricultural, medical and other scientific fields. China's first experimental reactor reportedly has produced over 30 different radioactive isotopes, including cobalt ^{60}, sodium ^{24}, phosphorus ^{32}, and calcium ^{45}. A partial list of isotope uses shows that they have been employed in industry with Chinese-produced gamma-ray instruments for detecting flaws in machinery; in geology for radioactive deep well surveying instruments to detect types of rock and geological formation of strata (see FIGURE 73–10); in medicine in radioactive cobalt apparatus for curing tumors and cancer (see FIGURE 73–11); and in agriculture to improve fertilization and cultivation of crops.

Directives for the Second Five Year Plan (1958–62) do not include nuclear power stations; however, in 1956, the Minister for Power declared that "atomic power stations would be built." Additional unconfirmed information has indicated that the Soviet Union will, during the Second Five Year Plan, furnish the country with two atomic power stations. There is no information to confirm the existence of any nuclear power program in Communist China. Nevertheless, in 1959 the

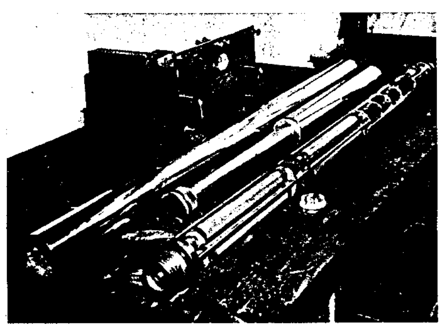

FIGURE 73–10. CHINESE-PRODUCED RADIOACTIVE DEEP-WELL SURVEYING EQUIPMENT

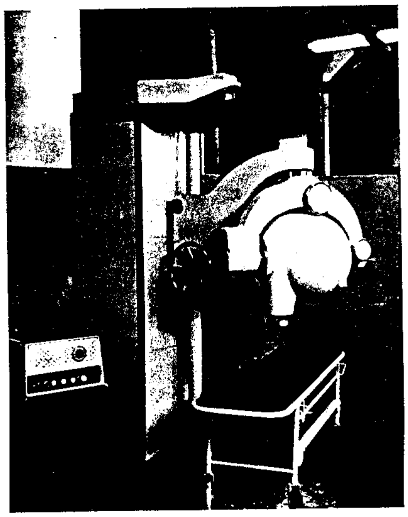

FIGURE 73–11. RADIOCOBALT UNIT FOR MEDICAL THERAPY, SHANGHAI, 1958

FIGURE 73–13. THREE-WATT RESEARCH REACTOR DURING CONSTRUCTION, NANKAI UNIVERSITY, TIENTSIN, 1958

Chinese Government reportedly was preparing to recall its atomic scientists studying in Europe, excluding the U.S.S.R., to assist in the building of atomic powerplants in Lan-chou and Pao-t'ou.

F. Significant research, development, and production facilities

See FIGURE 73–12 for a glossary of organizations concerned with atomic energy.

Chinese University of Science and Technology (Chung-kuo K'o-hsueh Chi-shu Ta-hsueh), Peiping—President: Kuo Mo-jo, who is also president of the Chinese Academy of Sciences. The university is under the joint control of the Ministry of Education and the AS. It was established in September 1958 to provide qualified scientists to staff the institutes of the AS. It has 13 departments, one of which is for nuclear physics and engineering. The original enrollment totalled 1,600 students.

Department of PHYSICS, Nankai University, Tientsin, Hopei province—Head: Professor Chiang An-ts'ai. In accordance with the Twelve Year Plan for Science, this university was to become one of the centers for nuclear research, and was to be comparable with Leningrad University, U.S.S.R., in size, standard and amount and quality of research by 1967. The Physics Department has built a small homogeneous experimental atomic reactor with a maximum permissible power of 3 watts (see FIGURE 73–13), in addition to a high-pressure electronic static electricity accelerator with a capacity of 2 Mev., and also a beta spectrometer for the study of isotope properties and nuclear structure.

Hsi-an Atomic Energy Research Center (Hsi-an Yuan-tzu-neng Yen Chu-shih), Sian—Director: Dr. Ch'ien San-ch'iang, also director of the IAE in Peiping. Located on the campus of Chiao-t'ung University, the center is a branch of the IAE and comes under the control of the Shensi Branch of the Chinese Academy of Sciences. The staff numbers about 1,245 employees, including 22 Soviet and Soviet bloc scientists as advisers. The center, jointly with the Physics Department of Chiao-

FIGURE 73–12. GLOSSARY OF CHINESE COMMUNIST ORGANIZATIONS CONCERNED WITH ATOMIC ENERGY

- Academy of Sciences (*Chung-kuo K'o-hsueh-yuan*), AS, Peiping.
- Central China Engineering Institute (*Hua-chung Kung-hsueh-yuan*), Wuhan.
- Chinese Academy of Agricultural Sciences (*Chung-kuo Nung-yeh K'o-hsueh-yuan*), Peiping.
- Chinese University of Science and Technology (*Chung-kuo K'o-hsueh Chi-shu Ta-hsueh*), Peiping.
- Hsian Atomic Energy Research Center (*Hsi-an Yuan-tzu-neng Yen-chiu-shih*), Sian.
- Institute of Physics (*Wu-li Yen-chiu-so*), Peiping.
- Institute of Atomic Energy (*Yuan-tzu-neng Yen-chiu-so*), IAE, Peiping.
- Institute of Chemistry (*Hua-hsueh Yen-chiu-so*), Peiping.
- Institute of Geology (*Ti-chih Yen-chiu-so*), Peiping.
- Institute of Mathematics (*Shu-hsueh Yen-chiu-so*), Peiping.
- Laboratory of Agricultural Application of Atomic Energy (*Yuan-tzu-neng Nung-yeh Ying-hung Yen-chiu-shih*), Peiping.
- Mining and Technological School, A'k'o-su.
- Ministry of National Defense (*Kuo-fang Pu*).
- Peiping University (*Pei-ching Ta-hsueh*), Peiping.
- Physics Department of Southwest Normal College (*Hsi-nan Shih-fan Hsueh-yuan*), Chungking.
- Sino-Soviet Non-Ferrous and Rare Metals Company, Urumchi.
- Tientsin University (*T'ien-ching Ta-hsueh*), Tientsin.
- Tsinghua University (*Ching-hua Ta-hsueh*), Peiping.

t'ung University, has manufactured an electronic accelerator with a maximum planned capacity of 1.5 Mev.

Institute of Physics (*Wu-li Yen-chiu-so*), *AS, Peiping*—Head: Dr. Shih Ju-wei, who received his training in the United States, and who has been identified as one of China's leading nuclear scientists. Subordinate to the Chinese Academy of Sciences, the institute concerns itself mainly with fields such as solid luminescence or radiation, metal physics, and various other subjects related to atomic energy and applied physics.

Institute of Atomic Energy (*Yuan-tzu-neng Yen-chiu-so*), *IAE, Peiping*—Head: Dr. Ch'ien San-ch'iang, who was trained in France. Subordinate to the AS, the institute conducts most of the research in Communist China in atomic energy (see FIGURE 73–3). The institute is capable of carrying out advanced research in the field of atomic energy for which it has ample funds, outstanding scientists, and sufficient equipment. The institute controls the research done with the Soviet-supplied 7.5–10-mw. research reactor and 25-Mev. cyclotron, both of which are located some 22 miles southwest of Peiping and slightly less than 6 miles west-northwest of Liang-hsiang. Other equipment in use at the institute northwest of Peiping includes two Van de Graaff accelerators (2.5 Mev. and 0.75 Mev.), various counters, vacuum pumps, a decatron, numerous spectroscopes and microscopes, and other varied measuring instruments. Although there is a sufficient number of scientifically well-qualified scientists to occupy the top level positions within the institute, there is a shortage of sufficient research personnel; however, improvement should be noted. The Chinese University of Science and Technology is greatly emphasizing training relating to nuclear energy and is expected to direct many of its graduates into the IAE and its branch institutes, as well as into institutes of the AS. Branches of the IAE have been reported at Sian, Shensi province; Lan-chou, Kansu province; Wu-han, Hupeh province; Ch'eng-tu, Szechwan province; and Urumchi, Sinkiang province, which are administratively controlled by the corresponding branch of the Chinese Academy of Sciences at these locations. High energy nuclear physics research is carried out by a group of the institute's scientists at JINR.

Research at the IAE has dealt largely with the production of radioisotopes and atomic energy equipment, with considerable emphasis on theoretical research. Recent work includes studies of weak interaction between nuclei and elementary particles, and work on the development of milli-microsecond pulse techniques. This latter work would seem to imply that future work in the relatively sophisticated field of neutron time of flight will be done.

Institute of Geology (*Ti-chih Yen-chiu-so*), *Peiping*—Head: Hou Te-feng. The institute is subordinate to the Chinese Academy of Sciences and has a laboratory located in Ch'ang-ch'un, Kirin province (head: Yu Te-yuan). The institute is also affiliated with the Ministry of Geology, and currently carries out all the research for the ministry in support of the numerous geological surveys being conducted in China.

Laboratory of Agricultural Application of Atomic Energy (*Yuan-tzu-neng Nung-yeh Ying-yung Yen-chiu-shih*), *Peiping*—Director: Dr. Hsu Kuan-jen, who was educated in the United States. Established 26 August 1957, the laboratory is under the Chinese Academy of Agricultural Sciences (*Chung-kuo Nung-yeh K'o-hsueh-yuan*). It is the leading research organ for the study of applications of radioisotopes and ionizing radiation in agriculture, especially in regard to plant cultivation.

Peiping University (*Pei-ching Ta-hsueh*), *Peiping*—Vice president of the university: Chou P'ei-yüan, often identified as one of China's leading nuclear scientists. Its departments of Physics, Atomic Energy, and Radio Electronics comprise one of the centers for nuclear research under the Twelve Year Plan for Science. Teachers and students of the Department of Physics produced a 0.7-Mev. electrostatic accelerator.

G. Outstanding personalities

CHANG Chia-hua, Dr. (1728/1367/5478) *—Nuclear physics. Research scientist at the IAE since 1958. Returned to Communist China in 1955 after having spent several years studying at the University of Washington and working as an instructor at Oklahoma A&M. In 1956, he published a paper entitled, "Positrons," and in 1958, a paper dealing with Chinese accomplishments in the use of radioactive isotopes in recent years. Born: 15 October 1915.

CHANG Wen-yü, Dr. (1728/2429/5940)—Nuclear physics and cosmic rays. Deputy director of the IAE since 1959; he has been a member of the staff of the institute since 1956, when he returned to Communist China from the United States. Dr. Chang served as a research professor in atomic and theoretical physics at Purdue University, 1949–56; visiting professor in physics, Princeton University, 1946–49; research associate in physics, Princeton University, 1943–46. Awarded a Ph.D. degree from Cambridge University, United Kingdom, 1938. He became a professor of physics at National Southwest University in China, 1934–38, prior to his work in the United States. Dr. Chang has conducted research on radioactivity, nuclear disintegra-

* Standard Telegraphic Code (STC) numbers, numerical representations of Chinese characters, are given for the names of those individuals for whom Chinese characters are available.

tions by high speed particles, interaction of mesons with matter, and cosmic rays. In his study on cosmic rays, he has done research on gamma rays originating from mu-mesons in lead and iron. He is the author of numerous scientific papers, including "Analysis of Beta-disintegration Data"; "Study of Showers Produced in Lead, Carbon, Beryllium"; and "Further Results from the Study of Sea Level Penetrating Showers." Born: 9 January 1910.

CHAO Chung-yao, Dr. (6392/1813/1031)—Nuclear energy. A member of the scientific council of JINR, Dubna, U.S.S.R., since 1957. He is also a deputy director of the IAE, and has been affiliated with this institute since 1951, then the Institute of Modern Physics. Has studied at California Institute of Technology; Massachusetts Institute of Technology; University of Halle, East Germany; and Cavendish Laboratory, Cambridge. Author of at least two books dealing with principles of nuclear energy, he was credited by the late Dr. Robert Millikan with the discovery of gamma rays produced by the annihilation of a positron and a negatron through collision. Born: 22 May 1902.

CH'IEN San-ch'iang, Dr. (6929/0005/1730)—Nuclear physics. Regarded as Communist China's leading nuclear physicist. Director, IAE since its inception in 1950. Dr. Ch'ien holds or has held many important scientific positions in Communist China since he returned in 1948 from France, after having received a Ph.D. degree from the University of Paris in 1943. He was Chief of Research, National Center for Scientific Research (*Centre National de Recherches Scientifiques*), 1944–48. Dr. Ch'ien currently holds several positions within the Academy of Sciences (Secretary General, since 1954; member of the Department of Physics, Mathematics and Chemistry; and Chief of the Hsi-an Atomic Energy Research Center, of the Shensi Branch of the Academy of Sciences). Although he is not believed to have been engaged in research since 1949, he did much valuable research prior to that time. His most important and best known work was the discovery of the third and fourth phases of nuclear fission. Born: 13 October 1913.

CHOU P'ei-yüan, Dr. (0719/1014/3293)—Theoretical physics, specializing in aerodynamics and fluid mechanics. Vice president, Peiping Unversity and member of the standing committee, Department of Physics, Mathematics and Chemistry, Academy of Sciences. Secretary of the World Federation of Scientific Workers. An active Communist Party member. After receiving a doctorate degree in physics from California Institute of Technology in 1928, Dr. Chou returned to China where he became a professor of physics at National Tsinghua University, and subsequently at National Southwest College. In 1955 he was member of the Atomic Energy Utilization Committee, and continues to be important in determining scientific policy. The greater portion of Chou's research was carried on in the early years of his scientific career. His most recent thesis, in 1956, was entitled, "The Vorticity Structure of Homogeneous Isotropic Turbulence in its Final Period of Decay." Born: 28 August 1902.

CHU Hung-yuan (2612/3163/0337)—Cosmic rays. Presently at JINR, Dubna U.S.S.R. Has been a researcher at the IAE since at least 1956. Educated in the United Kingdom prior to his return to Communist China, about 1955. Recently published research includes: "The Electric Multi-pole Internal Conversion Induced by Neutron Transition," and "Angular Distribution of the Decay Products of the Hyperon."

HSIEH Chia-lin, Dr. (6200/1367/7782)—Nuclear physics. Research has been concentrated on the cyclotron at the IAE, with which he has been associated since 1956. In the United States, 1947–56, working and studying at the California Institute of Technology and at Stanford University. Subsequently, he worked as a research assistant in the microwave laboratory of Stanford University, became an instructor at the University of Oregon, 1952, and finally assumed the position of technical supervisor with the Argonne Cancer Hospital at the University of Chicago until his return to China. Two of his papers, published in 1957, were entitled: "A New Method of Beam Extraction for the Electron Cyclotron," and "Contributions to the Theory of Wave Guides with Stratified Medium." Born: 8 August 1920.

HU Ning, Dr. (5170/1380)—Nuclear physics. Currently, a member of the Scientific Council of JINR. Dr. Hu has been affiliated with the IAE, as well as serving as professor in the Department of Physics at Peiping University, since 1953. Prior to his return to Communist China in 1950, he was on the staff of the National Research Council, Ottawa, 1949–50; a staff member, Department of Physics, Wisconsin University, 1948–49; and did post-doctorate work at the Institute of Theoretical Physics, Copenhagen University prior to 1948. Dr. Hu received his Ph.D. degree in nuclear physics from California Institute of Technology in 1944. Has done research at the Institute for Advanced Studies, Princeton. His theses were entitled "On the Quadruple Correlation in Isotropic Turbulence," and "A Quantum Mechanical Theory of Neutrons." Included among his more recent publications are: "On Multiple Production of Mesons by High-Energy Nucleon Collisions," and "Further Investigation on the S-Matrix in Meson Theory." Born: 9 January 1915.

HUA Lo-Keng, Dr. (5478/5012/1649)—Mathematics. Communist China's leading mathematician, and director of the Institute of Mathematics of the Academy of Sciences since 1951. Since 1954, he has been a deputy director of the Department of Physics, Mathematics and Chemistry of the AS, as well as head, in 1956, of the preparatory committee for the establishment of the academy's Institute of Computation Techniques. Dr. Hua has held a number of important scientific posts after receiving his D.Sc. from Cambridge University. Has done research at the Institute of Advanced Studies, Princeton; and has served as professor in the Department of Mathematics of the University of Illinois prior to 1948. In 1948, after his return to China, he became a member of the Mathematical and Physical Sciences Group of the AS, until 1950, when he became professor of physics at National Tsinghua University. Research papers published in 1958 include "A Convergent Theorem in Space Forming by Continuous Function of a Densing Group," and "Harmonic Analysis of a Typical Form in the Theory of Function of Several Complex Variables." He received first prize in 1956 from the AS for the last work cited. From 1950 to early 1957, seventeen of his research papers were published. Born: about 1910.

KO T'ing-sui, Dr. (5514/1656/3606)—Physics of metals, spectroscopy. A member of the Scientific Committee of both the Institute of Physics, since 1956, and the Institute of Metallurgy and Ceramics, since 1955, of the AS (became deputy director of the latter institute in 1958). Also has been identified with the Scientific Committee of the Institute of Metals, Shenyang Branch of the Academy of Sciences, in 1954; from 1950–53, was a professor at Tsinghua University. Prior to his return to Communist China in 1950, Dr. Ko studied at the University of California and at the Massachusetts Institute of Technology. Served as assistant professor at the University of Chicago in 1949, where most of his work involved the deformation of metals and was done for the Office of Naval Research. He has done outstanding work, since his return to China, on the development of materials for use at high temperatures. Born: 3 May 1913.

LI Ssu-kuang, Dr. (2621/0934/0342)—Geology. One of Communist China's leading and certainly most influential geologists. Dr. Li holds or has held the following positions: Minister of Geology since 1954; member of the Department of Earth Sciences, AS, since 1955; vice president (one of several) of the academy since 1954; formerly director of both the academy's Institute of Geology, 1943–49, and the Institute of Paleontology, 1950–58. Dr. Li attended Birmingham University, United Kingdom, from which he received three degrees, and was awarded an honorary doctorate from the University of Oslo. He received the A. P. Karpinski Gold Medal for outstanding achievements in Geology, Paleontology, Petrography and Mineralogy from the Academy of Sciences, U.S.S.R. Since 1949, he has primarily served as an administrator and "popular front" representative for the Communist regime; however, on two occasions, he was reported as being closely associated with China's nuclear energy program. He met with Soviet and Chinese specialists in 1952 to discuss the exploitation of uranium deposits in Sinkiang Province; and, in 1955, he played an important part in formulating plans for the program as a whole. Born: about 1889.

P'ENG Huan-wu (1756/2719/2976)—Theoretical physics, specializing in quantum mechanics. Deputy director of the IAE, since 1952. Member of the standing committee, Department of Physics, Mathematics and Chemistry of the AS. Studied at the University of Michigan; worked as an assistant professor at the Dublin Institute for Advanced Studies prior to his return to Communist China in 1949. Served as professor of physics at Tsinghua University, 1950–52, when he became associated with the AS. In 1956, was a Chinese delegate sent to Moscow to plan for the establishment of the Joint Institute for Nuclear Research. In 1959, he was again in Moscow attending an International Conference on Cosmic Rays. Has written papers entitled: "Nuclear Forces" and "On the Binding Energies of the Atomic Nuclei H^2, H^3, He^3, and He^4"—the latter on which he collaborated with others. Date of birth unknown.

WANG Kan-ch'ang, Dr. (3769/3227/2490)—Nuclear physics. Deputy director and head of Chinese research at JINR, and associated with the institute since its beginning in 1956. After studying at the University of Berlin, he returned to China and worked as a professor of physics at Chekiang University until 1947, when he became a student at the University of California. Deputy director of the IAE, 1950–56. He recently has been credited as being one of the discoverers of a new nuclear particle, the anti-sigma-minus hyperon. Reportedly designed a large bubble-type chamber for the synchrophasotron, at JINR, as well as a radioactive counter and film detector. His recent papers include "Electron-Proton Showers in Lead," "A Suggestion on the Detection of the Neutrino," and "Nuclear Field and Gravitational Field." Born: 17 April 1907.

YEN Chi-tz'u, Dr. (0917/3444/1964)—Nuclear physics, specializing in optics and spectroscopy. Director of the Department of Technical Sciences of the AS since 1954, and currently a member of the Physics Faculty of the Chinese University of Science and Technology. Although possessing a high degree of technical competence, Dr. Yen has concerned himself largely with administrative duties in line with Communist Party directives since 1950. Studied at the University of Paris in 1927. Prior to 1946, he had published at least fifty scientific papers in English, French, and Chinese. His research efforts included studies of the resolution and shift of spectral lines in an electric field and the widening, shift, and asymmetry of atomic spectra of alkali metals. He has also done research on spectrography, piezoelectric crystals, applied optics, radiochemistry and crystallography. Born: 4 December 1900.

H. Comments on principal sources

Information on the Chinese Communist nuclear energy program has been derived principally from clandestine services reports and Chinese open literature. The reliability of the information is highly questionable and, for propaganda purposes, is often exaggerated. Nevertheless, except where doubts have been expressed, the material is believed to be accurate.

Much of the nuclear energy research and development activity underway within Communist China is concealed in the highest degree of secrecy. As a result, there continues to be a need for information on all phases of the Chinese Communist nuclear energy program, particularly as it relates to nuclear weapon production, nuclear power installations, and Soviet assistance in the program.

74. *Biological Warfare*

A. General

Although evidence does not point to the fact that Communist China presently is conducting an offensive BW program, there are indications of interest in the subject. The prodigious propaganda campaign of the Korean War against the United States, and the Chinese BW investigating committees formed during that period attest to the country's interest in BW. During a recent visit of a Hungarian Medical Mission to China, the Chinese Communists were reported to be interested in Hungarian research on anthrax because of BW implications. The Communist Chinese do not acknowledge having an offensive BW policy but, instead, describe the possible methods of offensive BW that other countries might employ against them.

Currently, the Chinese Communists are directing their microbiological research mainly toward improving the public health standards of the country, as well as toward controlling and eliminating serious animal diseases. This research has BW defense applications and, ultimately, may have some offensive BW implications; however, insufficient technically trained personnel is hampering Communist Chinese efforts to raise the level of health and sanitation and, consequently, would hinder the country from undertaking a major BW research effort. The Twelve Year Plan prepared by the Chinese Scientific Planning Committee in 1956 (now the (State) Scientific and Technological Commission (*K'o-hsueh Chi-shu Wei-yuan-hui*)), the highest research and development planning group in China, has yielded only a few significant results and, to date, the amount of independent research accomplished has been negligible.

B. Organization related to BW

Microbiological research planning of a military nature is carried out under the general direction of the (State) Scientific and Technological Commission, and is probably vested in the Ministry of National Defense (*Kuo-fang Pu*), particularly in the Chinese People's Liberation Army (PLA). Direction is also provided by the following: 1) Academy of Sciences (*Chung-kuo K'o-hsueh-yuan*), AS, Peiping; 2) Ministry of Public Health (*Wei-sheng Pu*); and 3) the Chinese Academy of Medical Sciences (*Chung-kuo I-hsueh K'o-hsueh-yuan*).

The Chinese Academy of Sciences controls a Department of Biology, which may oversee work related to BW. The Biology Department controls the Institute of Experimental Biology in Shanghai and several research institutes in Peiping, including the Institute of Microbiology. Work performed by the Institute of Microbiology includes aerobiology, antibiotics, and research on fungi.

The Ministry of Public Health controls several vaccine and antibiotics production plants and carries out its research and development work through its Chinese Academy of Medical Sciences, with several departments, including the Department of Virology. The academy has carried out considerable good quality research on viral disease agents as well as aerobiological research on viruses.

Within the Ministry of National Defense, and subordinate to the People's Liberation Army, is the Academy of Military Medical Sciences (*Chun-shih I-hsueh K'o-hsueh-yuan*), Shanghai. Although only occasionally has BW-related research been reported from this academy, it is believed that BW defense activities would be vested largely in this organization, as they are in the equivalent Soviet academy.

C. Research and development related to BW

Communist China has several microbiological installations and sufficient scientific personnel competent to conduct some basic research related to BW. While the Chinese Communists are not known to be developing any specific BW agents, certain research projects appear to be applicable to BW agent development, as well as to public health. High priority has been given to research and development of antibiotics and to the control of epidemic diseases. However, the present research facilities and personnel conducting research on vaccines, antibiotics, diseases, and other microbiological phases of public health activity are inadequate to meet the 1956 objectives as outlined in the country's Twelve Year Plan. Until these objectives are fulfilled, it is not expected that Communist China will expend much, if any, effort on BW research and development.

The following diseases, which are being actively studied to improve human and animal health, could ultimately have BW implications: plague, Japanese B encephalitis, Russian spring-summer encephalitis, yellow fever, influenza, brucellosis, and glanders. At the Central Institute of Biologicals (*Chung-yang Sheng-wu Chih-p'in Yen-chiu-so*), Peiping, studies are being conducted to determine the most favorable conditions for preparing living plague vaccine. The studies encompass problems of storage of the liquid and lyophilized vaccine. Research is being done by the Department of Microbiology, Shantung Medical College, Chi-nan, on a method (based on carbohydrate fermentation) for differentiating the species of *Brucella* (*abortus, suis, melitensis*). In the department of veterinary medicine of the agricultural research institute in Peiping, experiments are being conducted on the ticks *Dermacentor nuttalli* and *D. sinicus*, which can transmit brucellosis to cattle and sheep, to determine: 1) the life duration of *Brucella* in various tick species; 2) the site of parasitism; 3) the transformation of *Brucella* as a result of parasitism in ticks and the effect such transformation has on virulence; and 4) the problem of artificially infecting healthy ticks. (See SECTION 76, under Subsection C, Medical and Veterinary Sciences, and SECTION 45, Health and Sanitation, of the NIS for detailed, related information on disease research.)

Chinese Communist researchers evidence familiarity with Western and Soviet bloc research in aerobiology, much of which has been associated with BW research. Taking advantage of the world's literature on aerosol chambers and the biology of airborne infections, Chinese microbiologists and bioengineers have devised an improved aerosol chamber for research on highly infectious disease agents (see FIGURES 74–1 and 74–2). Reportedly, also, investigators have developed a new disseminating apparatus, based on two Western devices, which is designed to yield aerosol particles of desired sizes for infectious disease studies. The apparatus appears to be as well designed as those used in the West, and better designed than any described by the Soviets to date. No information is available on aerosol sampling techniques employed by the Chinese Communists.

Communist China is not believed to be producing any BW agent materiel. There is some evidence of BW defensive preparations under way in Communist China. BW defense in military training generally follows the pattern established by the U.S.S.R.

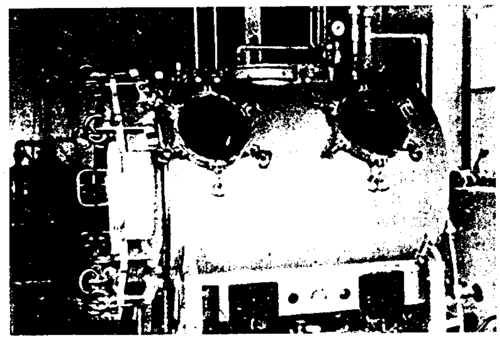

FIGURE 74–1. CHINESE COMMUNIST AEROSOL UNIT

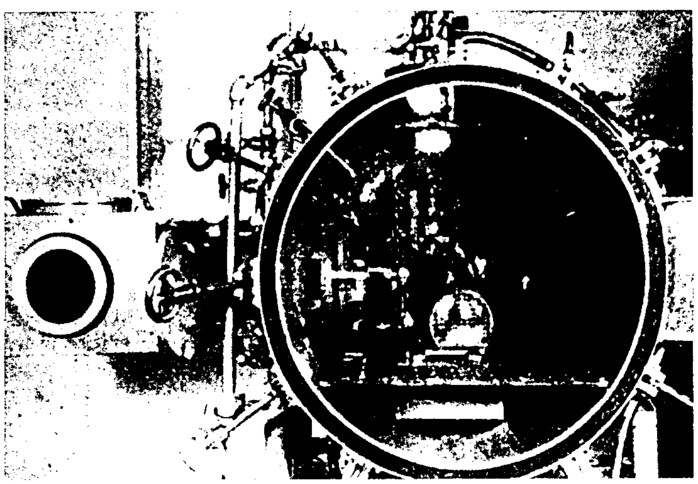

FIGURE 74–2. CHINESE COMMUNIST AEROSOL UNIT, INSIDE VIEW

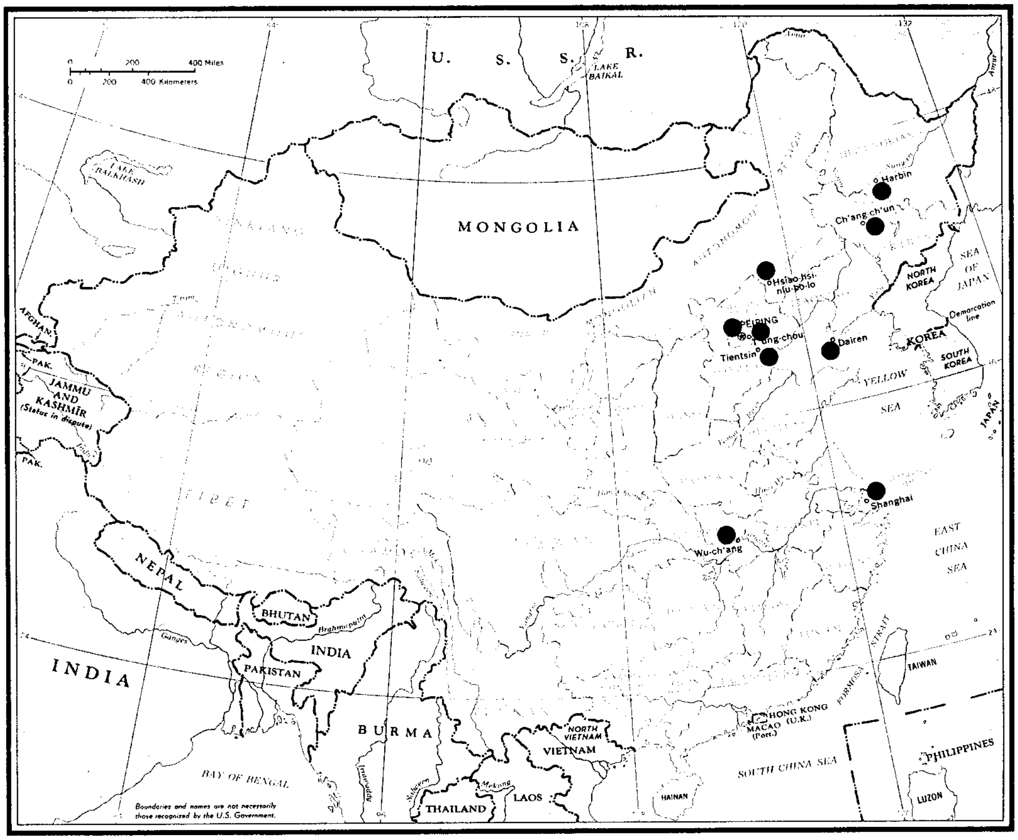

FIGURE 74-3. LOCATIONS OF FACILITIES POSSIBLY ENGAGED IN RESEARCH WITH BW IMPLICATIONS

LOCATION, BY PROVINCE—SIGNIFICANCE

HEILUNGKIANG

HARBIN (45°45′N., 126°39′E.)—Institute of Veterinary Medicine.

HOPEH

TIENTSIN (39°08′N., 117°12′E.)—Industrial Hygiene Experimental Laboratories.

HUPEH

WU-CH'ANG (30°32′N., 114°18′E.)—Hupeh Medical College; Central-South China Institute of Biologicals.

INNER MONGOLIAN AUTONOMOUS REGION

HSIAO-HSI-NIU-PO-LO (about 6½ miles west of Ch'ih-feng, 42°17′N., 118°53′E.)—Agricultural Experiment Station.

KIRIN

CH'ANG-CH'UN (43°52′N., 125°21′E.)—Ch'ang-ch'un Institute of Biologicals.

LIAONING

DAIREN (Ta'lien) (38°55′N., 121°39′E.)—Dairen Institute of Biologicals.

PEI-CHING SHIH

PEIPING (39°56′N., 116°24′E.)—Central Institute of Biologicals; Chinese Academy of Medical Sciences; Institute of Entomology, AS; Institute of Epidemiology; Institute of Microbiology, AS.

T'UNG-CHOU (39°55′N., 116°39′E.)—Bacteriology Laboratory.

SHANG-HAI-SHIH

SHANGHAI (31°14′N., 121°28′E.)—Central Health and Epidemic Control Station; Institute of Experimental Biology, AS; Shanghai Institute of Biologicals.

D. Significant facilities doing research and development related to BW

The microbiological installations described in the following tabulation reportedly have conducted, or are considered capable of conducting, research and development related to biological warfare (see also the map, FIGURE 74–3, which shows the distribution of these facilities).

LOCATION BY PROVINCE	FACILITY, SUBORDINATION, AND DIRECTOR	RESEARCH CAPABILITY
HEILUNGKIANG:		
Harbin	Institute of Veterinary Medicine (*Shou-i Yen-chiu-so*), formerly the Northeast Veterinary Research Institute (*Tung-pei Shou-i K'o-hsueh Yen-chiu-so*); also known as the Harbin Veterinary Research Institute, and the All-China Veterinary Scientific Research Institute. Subordinate to China Academy of Agricultural Sciences (Director: Hu Hsiang-pi, at least to 1957).	Glanders bacillus (*Malleomyces mallei*).
HOPEH:		
Tientsin	Industrial Hygiene Experimental Laboratories (*Kung-yeh Wei-sheng Shih-yen-yuan*), of the Ministry of Health (Director: Feng Chih-ying).	Industrial toxicology, dusts, and sanitation; physiopathology.
HUPEH:		
Wu-ch'ang	Hupeh Medical College (*Hu-pei I-hsueh-yuan*) (Chief of Microbiology: Hsiang Chin-min).	Microbiological studies.
	Central-South China Institute of Biologicals (*Chung-nan Sheng-wu-chih-p'in Yen-chiu-so*), also known as the Wuhan Institute of Biologicals (*Wu-han Sheng-wu Chih-p'in Yen-chiu-so*).	Vaccine development.
INNER MONGOLIAN AUTONOMOUS REGION:		
Hsiao-Hsi-Niu-Po-Lo.	Agricultural Experiment Station (*Nung-yeh Shih-yen-ch'ang*).	Livestock and animal products.
KIRIN:		
Ch'ang-ch'un.	Ch'ang-ch'un Institute of Biologicals (*Ch'ang-ch'un Sheng-wu Chih-p'in Yen-chiu-so*).	Vaccines, therapeutic agents, and serums for use against smallpox, cholera, typhus, plague, dysentery, diphtheria, rabies, Japanese B encephalitis, Russian spring-summer encephalitis, typhoid-paratyphoid fevers, and gangrene. Large numbers of animals are available for research at the institute. There is a small-scale capability for BW research.
LIAONING:		
Dairen (Talien).	Dairen Institute of Biologicals (*Ta-lien Sheng-wu Chih-p'in Yen-chiu-so*) also known as the Dairen Organic Center (Scientific director: Wei Hsi).	Primarily on infectious diseases; in 1955, reportedly, investigating defensive BW and studying Japanese BW literature. Appears to be capable of small-scale BW agent production.
PEI-CHING-SHIH:		
Peiping	Central Institute of Biologicals, also known as the National Institute of Biologicals (*Chung-yang Sheng-wu Chih-p'in Yen-chiu-so*) (Director: Tang Fei-fan; head of Virology Department: Huang Chen-hsiang). Affiliate institutes are also located at Ch'ang-ch'un, Dairen, Hankow, Shanghai, and K'un-ming.	Actively engaged in developing and manufacturing vaccines, antibiotics, and immunizing serums. Also produces vaccines for brucellosis, cholera, plague, smallpox, and yellow fever. Continues to search for new strains of influenza for vaccine purposes. Appears to have a fair capability for small-scale BW production with little modification of existing facilities.
	Chinese Academy of Medical Sciences (*Chung-kuo I-hsueh K'o-hsueh-yuan*), which succeeded the National Institutes of Health; has at least 10 departments in Peiping and other components (institutes) in Peiping, Nanking, and Tientsin.	Virology; pharmacology; pathology; physiology; antibiotics; parasitic diseases; medicinal substances of plant, animal, and mineral origin; experimental biology, etc.

LOCATION BY PROVINCE	FACILITY, SUBORDINATION, AND DIRECTOR	RESEARCH CAPABILITY
PEI-CHING-SHIH (*Continued*):		
Peiping (*Con.*).	Institute of Entomology (*K'un-ch'ung Yen-chiu-so*), AS (Director: Chen Shih-hsiang).	Research data not available.
	Institute of Epidemiology (*Liu-hsing-ping Yen-chiu-so*), subordinate to Chinese Academy of Medical Sciences (Director: Chen Wen-kuei).	Research data not available.
	Institute of Microbiology (*Chung-kuo K'o-hsueh-yuan Yen-chiu-so*), AS; formerly, the Commission for the Preservation of Cultures of Micro-organisms (Director: Fang Hsin-fang).	Industrial, antibiotic, and mold prevention microbiology. Other work concerns preservation, classification, and mutation of bacterial strains; and mutation for breeding purposes, rather than for hereditary studies.
T'ung-hsien...	Bacteriology Laboratory (Chinese title, subordination, and director unknown).	Possibly doing research and development on BW because of the high degree of secrecy maintained and the precautions taken.
SHANG-HAI-SHIH:		
Shanghai.....	Central Health and Epidemic Control Station (*Chung-yang Wei-sheng Fang-i-chan*), Ministry of Health (Director: Tu Kau-pin).	Epidemiology, sanitation, and industrial health. Diseases under study are smallpox, cholera, plague, diphtheria, typhoid and paratyphoid fevers, dysentery, Japanese B encephalitis, filariasis, schistosomiasis, hookworm, and malaria.
	Institute of Experimental Biology (*Shih-yen Sheng-wu Yen-chiu-so*), subordinate to Chinese Academy of Sciences (last known director: Pei Shih-chang, who has subsequently gone to the Institute of Biophysics).	Research data not available.

E. Outstanding personalities

CHANG Tsung-pao—Microbiology, entomology. Was last reported to be staff member, Virus and Medical Entomology Laboratories, at the Central Institute of Biologicals. Publications: *Isolation of Japanese Type B Encephalitis Virus from Mosquitoes* and *A Report of Seasonal Distribution of Mosquitoes Both in Human Dwellings and Cow Stables in Dairen During 1953;* co-author of *On the Problems of Transmittal of Viruses of Japanese Encephalitis.*

CHANG Wei-shen (1728/3634/3947), Dr.—Microbiology and biochemistry. Staff member, Antibiotics Laboratory, Central Institute of Biologicals, 1952, and director of this laboratory since 1955. Professor, Department of Agricultural Chemistry, Northwest College of Agriculture, 1951. Educated in the United States at the University of Wisconsin. Presented the paper, "The Effect of Addition of Lactose to the Medium to Increase Penicillin Output," before the International Conference on Antibiotics, Warsaw, January 1955. Attended Symposium of Antibiotics, Prague, 1959. Born: 1909.

CHEN Wen-kuei (7115/2429/6311),* M.D.—Bacteriology; specializing in plague prevention and in the production of sera and vaccines. Director, Institute of Epidemiology, Peiping. Conducted research on plague at Bombay under the auspices of the League of Nations, 1936; shortly thereafter was assistant technical expert, National Health Administration in Nanking. During the period 1941–45, was head of the Department of Laboratory Medicine of the Emergency Medical Training School, Kweiyang, and in charge of a vaccine-producing plant. In 1950, accused the Japanese of having dropped plague bacilli at Chang-teh in Hunan province and supported a Soviet proposal that the Japanese be brought to trial for using BW. Chief of Medical Service, Chinese People's Volunteers in Korea, late 1952. Head of Chinese delegation, Hungarian Microbiological Society Congress, Budapest, January 1951; attended Congress of the People for Peace, Vienna, December 1952; delegate, Asian and Pacific Peace Conference, Peiping, September 1952. Attended both the Vienna and Peiping Peace Conferences, where he supported claims that the United States engaged in BW in Korea. Attended public health conferences in Poland in 1956, and a meeting at the Institute "Mikrob," Saratov, U.S.S.R. in 1957 on "Natural Nidus and Epidemiology on Especially Dangerous Diseases." Born: about 1897.

HUANG Chen-hsiang—Virology. Head of the Department of Virology, Central Institute of Biologicals, Peiping. Editor of *Acta Virologica* (Virology Transactions), a Czechoslovak publication, and a colleague of Dr. Ivan Malek, director of the Biology Institute, Prague. Huang's main research interests have been the neurotropic viruses. Publications: "The Pathogenicity of Different Strains of Japanese B Encephalitis Virus Isolated from Humans, Swine, and Mosquitoes"; "Studies in Factors Causing Subclinical Infections of Japanese Type B Encephalitis"; "The Effect of Hypotonic Saline Stimulation of the Replication of Influenza Virus and its Adaptation to the Mouse Lung"; and "A Strain of Japanese B Encephalitis Virus with High Subcutaneous Lethality for White Mice."

HUANG Yuan-tung—Microbiology. Staff member of the Central Institute of Biologicals, Peiping. Co-author with Chu Chi-ming of the article "Laboratory Techniques in the Study of Influenza—Preparation of Filtrate from Culture of *Vibrio cholera.*" Has collaborated with Tang Fei-fan on the study of the morphology of the trachoma virus, its separation, and biological properties. Has written for the *National Medical Journal of China.*

* Standard Telegraphic Code (STC) numbers, numerical representations of Chinese characters, are given for the names of those individuals for whom Chinese characters are available.

LIAO Yen-hsiang, Dr.—Veterinary medicine, but specializing in bacteriology. Head: Department of Microbiology, Northwest College of Animal Husbandry and Veterinary Medicine, in 1956. Studied in the United States at the University of Kansas. While in the United States (1950–51), he reportedly accepted a Chinese Communist offer to become deputy director of the Biological Research Institute in Peiping. Has been associated with Hsueh Pai, a Chinese Communist bacteriological expert. He visited the U.S.S.R. in June 1951 and, while there he: reportedly received an honorary degree, lectured to Soviet scientists on U.S. bacteriological research, and studied the results of Japanese bacteriological research.

T'ANG Fei-fan (3282/7378/0416), M.D.—Microbiology, specializing in antibiotics production. Director and chief technical expert of the National Vaccine and Serum Institute, now the Central Institute of Biologicals, Peiping, from 1938 to the present. Chairman, Bio-Culture Preservation Committee, AS. Research fellow in bacteriology, Peiping Union Medical College, 1921–24; and at the Medical School, Harvard University, 1924–27. On returning to China, became professor of bacteriology, Shanghai Medical College, 1927–31; then head of the Department of Bacteriology, Henry Lester Institute, Shanghai. Visiting research fellow at the National Institute for Medical Research, Hampstead, London, 1935–37. Chairman of a Germ Warfare Prevention Committee, and president of the Chinese Society of Microbiology, 1952. Author: "Studies on the Etiology of Trachoma I—Studies of the Inclusions of Trachoma," and numerous other scientific articles. Born: 1889.

WEI Hsi (7614/2569), M.D.—Bacteriology. Specializing in rickettsial diseases and vaccine and serum production. Professor and head, Department of Bacteriology, Dairen Medical College. Fellow (1933–34) and assistant (1934–37), Henry Lester Institute, Shanghai; research fellow in bacteriology, Harvard University Medical School, 1937–38. In charge of the standardization department of the National Vaccine and Serum Institute, K'unming, 1938 to about 1946 and head of the K'un-ming branch of this institute, about 1946–47. Consultant editor on bacteriology for *Scientific World*, 1948. Member of International Scientific Commission that investigated BW in China and Korea. Member, National Committee, All-China Federation of Scientific Societies, 1953. At this time, returned a medal of meritorious service, which had been presented to him for his work with the U.S. Typhus Commission, 1945–46. Author: "Studies on *Streptococcus scarlatina* in Shanghai"; "Investigation of the Causal Agent of Bovine Pleuropneumonia"; and others. Born about 1903.

F. Comments on principal sources

The information in this Section is derived from official reports and sources. Although the material is reliable, the content is inadequate and there are many gaps in the information. Data are lacking on BW research and development organization, and on research and development projects applicable or related to BW. Information is desirable on: installations and personalities which are doing microbiological research and development with possible BW implications; and the nature and extent of Soviet technical assistance to Communist China in fields related to BW.

75. Chemical Warfare

A. General

1. Capability and trends

Communist China has a poor offensive and defensive chemical warfare (CW) capability. Without Soviet assistance, the Communist Chinese currently cannot provide sufficient toxic chemical agents to sustain offensive CW. They do, however, have a fair-to-good capability for disseminating toxic chemical agents from sizable quantities of Soviet-type ground and air weapons and for waging smoke and flame warfare. There is a serious shortage of defensive material for troops and no protective equipment for civilians.

The Chinese apparently have begun a limited CW research and development program. The reported toxic agent research is primarily on work on the old standard agents, although intermediates common to both insecticide and V-agent production have been synthesized. There is no evidence of research on psychochemical or other new agents.

Communist China's CW research is limited by the lack of adequate research facilities and the acute shortage of qualified scientists and technicians; however, there are a number of Western-trained Chinese scientific personnel who could direct the development of a competent CW program and could train the necessary personnel.

2. Policies

The Chinese Communists evidently are planning to improve their capability for CW offense. In 1956, they announced a 12-year research and development program, which has been supported by a progressively larger annual budget. This program emphasizes economic and military—probably including CW—requirements. Also, the Chinese apparently intend to develop a good military defense against CW weapons, although Chinese Communist leaders seem unconcerned about protecting the civilian population against CW attack.

Soviet support has been necessary for any CW research the Chinese have conducted. Since 1949, Chinese Communist Army personnel have been sent to the U.S.S.R. for CW training—some probably to the Military Academy of Chemical Defense. Further assistance probably has come from Soviet scientists knowledgeable of CW agents and their production who have been invited to visit China for tours and lectures.

There is little likelihood that Chinese Communist leaders would consider making a unilateral decision to initiate CW warfare until reliance on Soviet logistical support has been reduced greatly.

3. Background and organization

Nationalist China produced and filled toxic agent munitions but did not employ them during World War II. The Nationalist Chinese also had a number of facilities for making protective masks—predominantly of Czech design.

Immediately after World War II, the Chinese Communists acquired large stocks of Japanese CW materiel. During the Korean campaign, they took over large quantities of U.S. CW equipment, primarily protective masks. This materiel is now considered ineffective. Since the outset of the Korean war, the U.S.S.R. has supplied the Chinese Communists with Soviet equipment, including protective masks and protective clothing, detection and decontamination equipment, smoke munitions, and portable flamethrowers.

During the Chinese civil war, the Communists had no CW organization; however, from 1946 to 1949 they sent selected officers and enlisted men to the U.S.S.R. for CW training; seven hundred reportedly were trained during the 1948–49 period alone. These Soviet-trained personnel formed the cadre from which the present chemical arm developed. During the Korean campaign, the Chinese Communist Army (CCA) engaged in smoke operations and some defensive training. Since then, the CCA has activated, equipped, and trained chemical units in increasing numbers. In 1954, it organized a Chemical Warfare Branch.

The Communist Chinese acquired scientific personnel of some potential value and a few CW research facilities from the Chinese Nationalists and probably began a limited CW research program about 1953 or 1954 with Soviet guidance, technical assistance, and financial aid.

Current overall high-level supervision of the Chinese Communist CW research and development effort—as all civilian and military research—is the responsibility of the State Council and its Scientific and Technological Commission

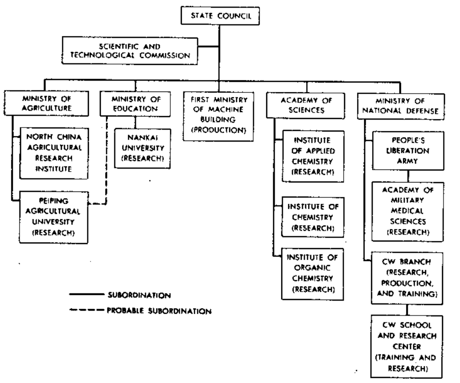

FIGURE 75–1. PROBABLE ORGANIZATION OF THE CHINESE CW EFFORT

(see FIGURE 75–1). The commission, which plans, coordinates, and supervises scientific research throughout the country, is responsible for placing the Chinese Communist armed forces on a modern basis by means of scientific research. In addition, two organizations on a lower level possibly are doing some CW planning and research: the Academy of Sciences (*Chung-kuo K'o-hsueh-yuan*), AS, Peiping, which is concerned with general scientific research, and the Academy of Military Medical Sciences, Chinese People's Liberation Army (*Chun-shih I-hsueh K'o-hsueh-yuan*), Shanghai.

The Chemical Warfare Branch of the army, is believed to function as a separate military service directly under the Ministry of National Defense (*Kuo-fang Pu*) and to have three principal subdivisions which are responsible for research, production, and training. The branch probably recommends the research projects that are desired to increase the CW capability of the army.

The First Ministry of Machine Building (*Ti-i Chi-hsieh Kung-yeh Pu*), which controls the production of arms and ammunition, is believed to be responsible for the production of CW materiel.

B. Research, development, and field testing

1. Offensive

a. CW AGENT RESEARCH AND DEVELOPMENT — Communist China apparently has begun a limited amount of CW research. Toxic agent research has been reported but is believed to consist primarily of work on the old standard agents, although it is definite that the Chinese Communists have known of the G-agent tabun since at least 1955. Several organizations are working on organophosphorus insecticides and the Peiping Agricultural University (*Pei-ching Nung-yeh Ta-hsueh*), Peiping, is conducting research on sulfur-containing organophosphorus compounds. The compounds synthesized are intermediates common to both insecticide and V-agent production. There is no evidence of research on psychochemical or other new agents. There are no known pilot plant operations or field testing of CW agents.

b. DISSEMINATION OF CW AGENTS — Communist China is not known to be conducting research and development on methods of disseminating CW agents.

c. FLAME WARFARE — Although Communist China has several plants capable of producing flame and smoke munitions, research in, and development and field testing of, these munitions has not been reported.

2. Defensive

a. DETECTION MATERIAL AND TECHNIQUES — The Chinese Communists have described some research in the field of automatic toxic chemical alarms. Such apparatus has a definite application to CW, especially for the detection of nerve agents lethal in minute quantities. They may have a capability to develop an automatic field alarm, based on their current industrial toxic alarm system.

b. PROTECTIVE CLOTHING AND MASKS — Communist China is producing Soviet-type heavy rubberized protective clothing for decontamination crews and toxic agent handlers and light rubberized fabric suits for CW reconnaissance personnel. These items, which provide good protection, and disposable impregnated paper capes or groundsheets, rubberized fabric gloves, and buskins are on issue to some troops. No details are available on the research and development of these items.

The Chinese Communists have conducted some research and development on protective masks, and they are believed to be producing military masks, apparently based on Soviet designs.

c. DECONTAMINANTS AND DECONTAMINATION EQUIPMENT — The Chinese Communists have the standard Soviet World War II personal decontamination kit, which is effective against vesicants only. They are not known to be conducting research and development in this field.

d. THERAPEUTIC AGENTS AND ANTIDOTES — There are no known research and development data on atropine (nerve agent antidote) and atropine syrettes, nor are the syrettes now on issue to troops.

C. Significant research and development facilities

Little is known of Chinese CW research and development facilities except that they are inadequate. The following are facilities suspected of engaging in, or having the potential to engage in, CW research and development. (FIGURE 75–2 is a glossary of organizations probably concerned with chemical warfare.)

Academy of Military Medical Sciences, Chinese People's Liberation Army (Chun-shih I-hsueh K'o-hsueh-yuan), Shanghai—Commandant: Chien Hsin-chung in 1958. Deputies: Shen Ko-fei in June 1956 and Tsai Chiao in September 1959. The academy was established in 1951 and is subordinate to the Ministry of National Defense. It has departments for biochemistry, nutrition, parasitology, pharmacology, and physiology. Research on organophosphorus compounds for insecticides gives the academy CW potential. Some of the organophosphorus research here was done in collaboration with the Institute of Organic Chemistry, Academy of Sciences, Shanghai.

Chemical Warfare School and Research Center, Ch'ang-p'ing—Director: Chang Nai-keng in 1953. Although primarily a CW training school for officers, there is some evidence of defensive research to discover techniques for protection against toxic gases and methods of treatment and rehabilitation after exposure (see FIGURE 75–3).

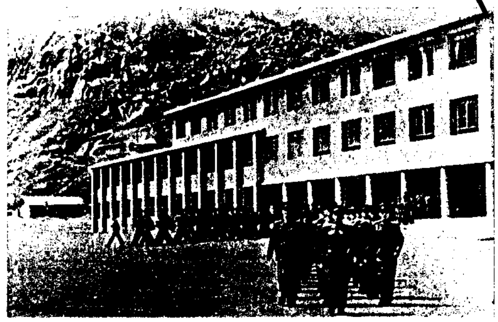

FIGURE 75–3. CHEMICAL WARFARE SCHOOL AND RESEARCH CENTER AT CH'ANG-P'ING

Institute of Applied Chemistry (Ying-yung Hua-hsueh Yen-chiu-so), Ch'ang-ch'un—Director: Dr. Wu Hsueh-chou since 1953. Subordinate to the Academy of Sciences, this institute was established in 1948. Applied research is underway in five laboratories devoted to inorganic, organic, analytical, synthetic, and physical chemistry. Chien Jen-yuan, who collaborated with Wu Jen-chieh in developing an automatic gas alarm which is believed capable of detecting nerve gases, is on the staff here. There were 180 total employees at this institute in 1958.

Institute of Chemistry (Hua-hsueh Yen-chiu-so), Chungkuantsun, Peiping—Director: probably Hua Shou-chun since 1957. Deputy director: Liu Ta-kang. This institute is subordinate to the Academy of Sciences. Current research includes polymer studies, raw materials for synthetic fibers, pharmaceuticals, organosilicons, and microanalysis. The institute has a staff of about 330, including 20 senior researchers and directors and 180 technicians. Chang Chun-i of this institute in writing on China's recent progress in organic chemistry has reported work on the relation of chemical structure of organophosphorus compounds to toxicity and on the rapid development in organofluorine compounds. In addition, an unspecified Academy of Sciences facility in Chungkuantsun reportedly has facilities for the synthesis and testing of "all kinds of poison gases."

Institute of Organic Chemistry (Yu-chi Hua-hsueh Yen-chiu-so), Shanghai—Director: Dr. Chuang Chang-kung since 1950. Deputy director: Dr. Wang Yu since 1954. Subordinate to the Academy of Sciences, this institute is currently doing research on antibiotics, vitamins and drugs, high molecular compounds, and organic chemical analysis. The institute worked with the Acad-

FIGURE 75–2. GLOSSARY OF CHINESE COMMUNIST ORGANIZATIONS PROBABLY CONCERNED WITH CHEMICAL WARFARE

Academy of Military Medical Sciences, Chinese People's Liberation Army (*Chun-shih I-hsueh K'o-hsueh-yuan*), Shanghai.	Institute of Organic Chemistry (*Yu-chi Hua-hsueh Yen-chiu-so*) Shanghai.
Chemical Warfare School and Research Center, Ch'ang-p'ing.	Ministry of National Defense (*Kuo-fang Pu*).
Chinese Academy of Sciences (*Chung-kuo K'o-hsueh-yuan*), AS, Peiping.	Nankai University (*Nan-k'ai Ta-hsueh*), Tientsin.
First Ministry of Machine Building (*Ti-i Chi-hsieh Kung-yeh Pu*).	North China Agricultural Research Institute (*Hua-pei Nung-yeh K'o-hsueh Yen-chiu-so*), Peiping.
Institute of Applied Chemistry (*Ying-yung Hua-hsueh Yen-chiu-so*), Ch'ang-ch'un.	Peiping Agricultural University (*Pei-ching Nung-yeh Ta-hsueh*), Peiping.
Institute of Chemistry (*Hua-hsueh Yen-chiu-so*), Peiping.	

emy of Military Medical Sciences on some organophosphorus research. One of the men who developed an automatic gas alarm is a member of the staff here. By 1958, the institute reportedly had a staff of about 200, including 13 senior research chemists.

Nankai University (Nan-k'ai Ta-hsueh), Tientsin—President and director of the Chemistry Department: Yang Shih-hsien since 1956. The university is subordinate to the Ministry of Education. Current research is concerned with insecticides, ion exchange resins, and organoarsenic compounds. The insecticide work has included research on organophosphorus compounds. Dr. Yang is reputed to be the only capable Chinese chemist interested in organophosphorus chemistry.

North China Agricultural Research Institute (Hua-pei Nung-yeh K'o-hsueh Yen-chiu-so), Peiping—Director: Ma Wen-ti'en, at least until 1955. The institute is under the direction of the Ministry of Agriculture and research is coordinated and approved by the Academy of Agricultural Sciences. Work on various insecticides is being conducted, including the organophosphorus compounds of systox, parathion, and "Preparation 1059," a systemic toxic. Personnel here are reported to have had intensive training both locally and abroad, and research and production equipment has been improved. The institute appears capable of developing a wide variety of toxic organophosphorus insecticides, which with very few changes could be converted to VG-type nerve agents.

Peiping Agricultural University (Pei-ching Nung-yeh Ta-hsueh), Peiping—Publications at the university reflect a strong interest in toxic organophosphorus compounds. One compound which contained sulfur is a V-agent intermediate. The work was done at the university's Department of Soils and Agricultural Chemistry, which has also done research on chloropicrin.

D. Outstanding personalities

The following personalities are suspected of, or are capable of, conducting CW research.

CHANG Nai-keng, Gen.—Deputy director, Chemical Warfare Branch in 1956. Reportedly, director, Chemical Warfare School and Research Center, Ch'ang-p'ing, in 1953. Prior to assuming his school post, he had been commander of an infantry unit. Educated in China.

CHANG Tseh-pu—Organic chemistry. Member, North China Agricultural Research Institute. Author of "Introducing Two Types of Organic Insecticides, Formula 'A' and 'D'" and co-author of "Investigation on the Aphicidal Effects of Systox Applied to Cotton Seeds," and "An Investigation of the Toxicity of Parathion in White Mice."

CHEN Ju-yu—Insecticides. Member, Department of Chemistry, Nankai University, working under the direction of Yang Shih-hsien. Obtained an M.A. degree, 1950, and a Ph.D. in Organic Chemistry, 1952, both from Indiana University. Returned to Nankai University, 1956. Has done research on the insecticide, malathion, and on the preparation of mono- and disubstituted dithiocarbamates.

CH'EN Shih-ts'ung—Organophosphorus chemistry. Member, Academy of Military Medical Sciences. Co-author of "Studies on Organo-amidophosphorus Compounds. II. The Influence of the Alkyl Radicals of Dialkylphosphites on the Preparation of Dialkylamidophosphonates."

CH'IEN Jen-yuan (6929/0086/0337) *—Physical chemistry. Member, Institute of Applied Chemistry, AS. Member, Institute of Physical Chemistry, Shanghai, 1954 to at least 1955. Member, Department of Chemistry, Chekian University, 1951. Studied at California Institute of Technology, 1944 and received Ph.D. from University of Wisconsin, 1946. Reads German and French. Worked on developing an automatic gas alarm which is believed capable of detecting nerve gases at the Institute of Chemistry, AS, Peiping. Author of "Atomic Values," "Relative Bond Polarity and Electronegativity Difference," and "Shear Dependence of the Viscosity of Polymethylmethacrylate in Benzene."

HU Ping-fang—Organophosphorus chemistry. Member, Department of Soils and Agricultural Chemistry, Peiping Agricultural University. Author of "Synthesis of Some Aryl Purimidyl Sulfones." Co-author of "Derivation of Chloropicrin from Non-toxic Isomers of Hexachlorane," "Researches on Organophosphorus Compounds. I. The Chlorination of 0,0-diethyldithiophosphoric Acid; II. Bis (0,0-dialkylthiophosphate) disulfides; III. The Synthesis of Ethyl Mercuric (Mercapto?) 0,0-dialkyldithiophosphates; and IV. Reaction of Some Alcohols With Phosphorus Pentasulfide."

T'UNG Tseng-shou—Organophosphorus chemistry; a leading research chemist. Member, Academy of Military Medical Sciences. Author of "Studies of Organo-amidophosphorus Compounds. I. Preparation of Dialkyl Esters of Amidophosphoric Acid." Co-author of "Studies on Organo-amidophosphorus Compounds. II. The Influence of the Alkyl Radicals of Dialkylphosphites on the Preparation of Dialkylamidophosphonates" and "Synthesis of Hypotensive Drug, 'Salsoline.' I. Acylation of Guaiacol."

WU Jen-chieh—Member, Institute of Organic Chemistry, AS. Worked on developing an automatic gas alarm which is believed capable of detecting nerve gases. Author of "A Continuous Differential Colorimeter. An Apparatus for Automatic Determination of Hydrogen Cyanide in Air."

YANG Shih-hsien (2799/4258/0341), Dr.—Organic chemistry; one of the outstanding organic chemists in China. President, Nankai University, since 1956; vice-president, 1953–56; professor, 1949–52 and 1931–40. Member, Standing Committee of the Department of Physics, Mathematics, and Chemistry, AS, since 1955. Member, Chinese delegation to U.S.S.R. to collect views of Soviet scientists on the Chinese Twelve Year Plan. Chairman, Board of Directors, China Society of Chemistry in 1956.

* Standard Telegraphic Code (STC) numbers, numerical representations of Chinese characters, are given for the names of those persons for whom Chinese characters are available.

Member, Scientific Committee, Institute of Applied Chemistry, AS, in 1956. Attended the signing of the Sino-Soviet Scientific Cooperation Agreement in 1959 and attended the Eighth Mendeleyev Congress in Moscow the same year. Attended colleges in the United States and obtained his Ph.D. at Yale in 1924. His most recent reported research has been on the synthesis of plant growth regulators. M. I. Kabachnik, the Soviet CW expert, stated [redacted] that, "In all of China there is only one man of importance, Prof. Yuan Si Shan (Yang Shih-hsien), who is interested in organophosphorus compounds." Born 1898.

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E. Comments on principal sources

The information in this Section was derived from open literature and official government sources. Although material on Chinese Communist CW research and development has increased slightly since 1953, specific information is lacking for the following reasons: Communist China began CW research and development probably as late as 1953 or 1954; strict security is imposed; little published literature is available; and CW can easily be disguised under other activities, such as a commercial insecticide program. Published information on certain fields of chemistry, though providing clues to CW research and its progress, has also been inadequate. Therefore, a definite, realistic report on Chinese Communist CW capabilities cannot be prepared.

In the absence of direct or confirmatory evidence, it has been necessary to estimate the nature and extent of the Chinese Communist CW effort. Some of the data used to prepare this Section have come from individuals whose reliability has not been established or who have not been technically qualified to obtain, assess, and report the desired information.

Much more current information is therefore needed on all phases of CW research and development to fill the major gaps, to confirm reports, and to evaluate properly the Chinese Communist CW program. Specific major gaps are the lack of detailed and clear information on organophosphorus (V-agent) research and development conducted for CW purposes, current Chinese Communist agent detection work, protective measures, therapeutic research and development, any agents standardized or being considered for standardization, the weapons being developed for agent delivery, and installations and personalities engaged in research and development for a definite CW military program and their current activities.

76. *Physical Sciences, Mathematics, and Medicine*

A. General

Communist China recognizes scientific research as an area of major importance in its bid for world power and recognition. The current and long-term emphasis on scientific research in Communist China is to strengthen the economy and industry which, in turn, contribute to military capability. The role of science significantly permeates state policy and planning. The central control and coordination of the ambitious scientific research program in Communist China is to improve utilization of the country's resources and to permit the application of the task force principle to critical scientific areas of economic, industrial, and military importance.

The Chinese Communist Party, through the State Council, generally supervises scientific research and development. The overall control, direction, and coordination of scientific research are exercised by the (State) Scientific and Technological Commission (*K'o-hsueh Chi-shu Wei-yuan-hui*). The Scientific and Technological Commission formulates broad scientific policy which influences the direction of research programs at the research institutes of the Chinese Academy of Sciences (*Chung-kuo K'o-hsueh-yuan*), AS, the institutes of the various ministries, and the provincial research institutes. (See Section 70 of this NIS, which describes in detail the activities of the commission and other organizations governing scientific and technical research in Communist China.)

The Scientific and Technological Commission has formulated a 12-year plan designed to elevate Communist China to a leading position in world science by the end of 1967. The plan calls for major effort in nuclear energy, electronics, chemistry, metallurgy, and similar fields that can make the greatest contributions to China's growth. Achievement of the projected goals, in the main, is dependent upon the following four factors: 1) sufficient trained manpower, which the country currently lacks; 2) an educational program, geared to training the number and quality of scientific personnel the country requires to staff its research facilities; 3) exploitation of foreign scientific literature, which is currently being actively undertaken; and 4) technical assistance from the Soviet bloc, which has been responsible for much of the significant progress that China has made to date. Despite advances, Communist China is not likely to achieve the scientific objectives specified in the 12-year plan, because of the emphasis on production at the expense of basic research and development, and the lack of qualified scientists.

During approximately ten years of collaboration with the Soviet Union, several scientific agreements, as well as a joint scientific research program, have been negotiated. Through these agreements, the Communist Chinese have been provided with Soviet technicians, equipment, literature, and educational opportunities; however, recent reports indicate that many Soviet engineers and technicians in Communist China have been recalled. This loss of Soviet technicians, with their probable replacement by Chinese researchers from the U.S.S.R. (most of whom have not fully completed their training and are lacking in technical experience), is expected to hinder research programs.

Within the last decade, but especially within the last two or three years, Communist China has been making progress in the basic sciences. In chemistry, the major work has concerned organic chemistry to utilize more fully the country's natural resources, and significant programs are underway in chemical engineering. Meteorological research has been directed toward increasing forecasting capabilities and expanding both the meteorological and hydrological network, in order to provide better support to the country's military programs and to advance industry. Oceanography is in its beginning stage, and most research has been in support of marine biology and fisheries to satisfy domestic needs for marine products. With considerable support from the U.S.S.R., work in geodesy and, particularly, in seismology, has seen the most notable progress. In physics, the emphasis is on theoretical and experimental nuclear physics. Mathematics lags due to a lack of trained researchers and due to the fact that available talent is consumed in providing support to solving problems in other fields of science. Much of the Chinese work in astronomy has concerned solar astronomy, ionospheric physics, and high altitude cosmic ray investigations, and a start has been made in radioastronomy.

Most medical research is concerned with eliminating the major public health scourges and improving sanitation. Other work has been in studying and exploiting indigenous plants for medical purposes and, in addition, the practices of acupuncture and cautery are being emphasized. To augment livestock production for domestic consumption, as well as for its value as an export commodity, some advances are being made in research and investigation related to protection of animal health. The major veterinary work has concerned rinderpest, hog cholera, glanders, and foot-and-mouth disease. Despite evident advances in almost all fields of research in Communist China during the past decade, most work has, of necessity, been in applied research to the detriment of basic and theoretical studies. (FIGURE 76–1 is a glossary of the organizations concerned with science and technology which are mentioned in this text.)

FIGURE 76–1. GLOSSARY OF CHINESE COMMUNIST ORGANIZATIONS CONCERNED WITH SCIENCE AND TECHNOLOGY

Academy of Military Medical Sciences, Chinese People's Liberation Army (*Chun-shih I-hsueh K'o-hsueh-yuan*), Shanghai.
Amoy University (*Hsia-men Ta-hsueh*), Amoy.
Astronomical Society of China (*Chung-kuo T'ien-wen Hsueh-hui*).
Bureau of Surveying and Cartography of the General Staff (*Tsung-ts'an Ts'e-hui Chu*), Peiping.
Bureau of Surveying and Cartography of the Ministry of Geology (*Ts'e-hui Chu Ti-chih Pu*), Peiping.
Central Institute of Biologicals (*Chung-yang Sheng-wu Chih-p'in Yen-chiu-so*), also known as the Central Biological Products Research Institute, Peiping.
Central Institute of Meteorological Research (*Chung-yang Ch'i-hsiang Yen-chiu-so*), Peiping.
Central Meteorological Bureau (*Chung-yang Ch'i-hsiang Chu*).
Chemical Industry Design Institutes (*Hua-hsueh Kung-yeh She-chi-yuan*), Peiping and Shanghai.
Chemical Society of China (*Chung-kuo Hua-hsueh Hui*).
China Federation of Scientific Societies (*Chung-hua Ch'uan-kuo Tzu-jan K'o-hsueh Chuan-men Hsueh-hui Lien-ho-hui*), Peiping.
China Medical College (*Chung-kuo Hsien-ho I-hsueh-yuan*), Peiping.
China Society of Physics (*Chung-kuo Wu-li Hsueh-hui*), also known as the Chinese Physical Society.
Chinese Academy of Agricultural Sciences (*Chung-kuo Nung-yeh K'o-hsueh-yuan*).
Chinese Academy of Medical Sciences (*Chung-kuo I-hsueh K'o-hsueh-yuan*), Peiping.
Chinese Academy of Sciences (*Chung-kuo K'o-hsueh-yuan*), AS, Peiping.
Chinese Medical Association (*Chung-hua I-hsueh-hui*), Peiping.
Chinese Physical Society (*Chung-kuo Wu-li Hsueh-hui*), also known as the China Society of Physics.
Chinese Society of Geodesy and Cartography (*Chung-kuo Ts'e-hui Hsueh-hui*), Peiping.
Dairen Chemical Plant (*Ta-lien Hua-kung-ch'ang*), Dairen.
Dairen Engineering College (*Ta-lien Kung-hsueh-yuan*), Dairen, also known as the Dairen Institute of Technology or Dairen Industrial College.
Dairen Institute of Biologicals (*Ta-lien Sheng-wu Chih-p'in Yen-chiu-so*), Dairen, also known as the Dairen Biological Production Center.
East China Agricultural Research Institute (*Tung-pei Nung-yeh K'o-hsueh Yen-chiu-so*), Nanking.
First Ministry of Machine Building Industry (*Ti-i Chi-hsieh Kung-yeh Pu*).
Fukien Institute of Oceanography (*Fu-chien Hai-yang Yen-chiu-so*), Amoy.
Fu-tan University (*Fu-tan Ta-hsueh*), Shanghai.
Geophysical Society of China (*Chung-kuo T'ch'iu Wu-li Hsueh-hui*).
Harbin (Polytechnic) Engineering College (*Ha-erh-pin (To-k'o-hsing) Kung-hsueh-yuan*).
Hydraulic Research Laboratory, Nanking, Mukden, Tientsin, Wu-kung, Wu-han, and Pang-fou of the Ministry of Water Conservancy and Electric Power.
Hydrologic Institute, Department of Geography, AS.
Hydroelectric powerplants, Canton and Shanghai.
Hydroelectric Power Research Institute, Peiping.
Institute of Applied Chemistry (*Ying-yung Hua-hsueh Yen-chiu-so*), AS, Ch'ang-ch'un.
Institute of Aquatic Products of the Yellow Sea (*Huang-hai Shui-ch'an Yen-chiu-so*), Tsingtao.
Institute of Atomic Energy (*Yuan-tzu-neng Yen-chiu-so*), IAE, Peiping.
Institute of Automation and Remote Control (*Tzu-tung-hua Chi Yuan-chu-li Ts'ao-tsung Yen-chiu-so*), Peiping:
Institute of Biochemistry (*Sheng-wu Hua-hsueh Yen-chiu-so*) Shanghai.
Institute of Biophysics (*Sheng-wu Wu-li Yen-chiu-so*), Peiping.
Institute of Blood Transfusion and Hemopathology (*Shu-hsueh Hsueh-i-ping-hsueh Yen-chiu-so*), Tientsin, also known as the Institute of Blood Transfusion and Hematology and Institute of Blood Transfusion and Hemopathy.
Institute of Botany (*Chih-wu Yen-chiu-so*), Peiping.
Institute of Chemistry (*Hua-hsueh Yen-chiu-so*), AS, Peiping.
Institute of Civil and Architectural Engineering (*T'u-mu Chien-chu Yen-chiu-so*), AS, probably Peiping.
Institute of Computation Techniques (*Chi-suan Ch'i-shu Yen-chiu-so*), AS, Peiping.
Institute of Electronics (*Tien-tzu-hsueh Yen-chiu-so*), AS, Peiping.
Institute of Entomology (*K'un-ch'ung Yen-chiu-so*), Peiping.
Institute of Epidemiology and Microbiology (*Liu-hsing-ping-hsueh Yu Wei-sheng-wu-hsueh Yen-chiu-so*), Peiping.
Institute of Experimental Biology (*Shih-yen Sheng-wu Yen-chiu-so*), Shanghai and Peiping.
Institute of Experimental Medicine, Peiping.
Institute of Geodesy and Cartography (*Ts'e-liang Chih-t'u Yen-chiu-so*), AS, Wu-ch'ang.
Institute of Geophysics and Meteorology (*Ti-ch'iu Wu-li Yen-chiu-so*), AS, Peiping.
Institute of Hydraulic Research (*Shui-li K'o-hsueh Yen-chiu-yuan*), Peiping.
Institute of Labor Hygiene, Labor Protection, and Occupational Diseases (*Lao-tung Wei-sheng Lao Tung Pao-hu Yu Chih-yeh-ping Yen-chiu-so*), Peiping, also known as the Institute of Industrial Hygiene.
Institute of Materia Medica (*Yao-wu Yen-chiu-so*), Shanghai, also known as the Institute of Pharmacology.
Institute of Mathematics (*Shu-hsueh Yen-chiu-so*), AS, Peiping and Shanghai.
Institute of Mechanics (*Li-hsueh Yen-chiu-so*), Peiping, also known as the Institute of Dynamics and Institute of Kinetics.
Institute of Medical Radiology (*Fang-she I-hsueh Yen-chiu-so*).

FIGURE 76–1 (*Continued*)

Institute of Metallurgy and Ceramics (*Yeh-chin T'ao-tzu Yen-chiu-so*), AS, Shanghai.
Institute of Metals (*Chin-shu Yen-chiu-so*), AS, Mukden.
Institute of Microbiology (*Wei-sheng-wu Yen-chiu-so*), Peiping, formerly Institute of Applied Mycology.
Institute of Oceanography (*Hai-yang Yen-chiu-so*), Tsingtao.
Institute of Oncology (*Chung-liu Yen-chiu-so*), AS, Peiping.
Institute of Optics and Precision Apparatus and Instruments (*Kuang-hsueh Ching-mi Chi-hsieh I-ch'i Yen-chiu-so*), AS, Ch'ang-ch'un.
Institute of Organic Chemistry (*Yu-chi Hua-hsueh Yen-chiu-so*) AS, Shanghai.
Institute of Petroleum (*Shih-yu Yen-chiu-so*), AS, Dairen.
Institute of Physics (*Wu-li Yen-chiu-so*), AS, Peiping, formerly the Institute of Applied Physics.
Institute of Physiology (*Sheng-li Yen-chiu-so*), Shanghai.
Institute of Psychology (*Hsin-li Yen-chiu-so*), Peiping.
Institute of Radio Techniques (*Wu-hsien-tien Chi-shu Yen-chiu-so*), Shanghai.
Institute of Semiconductors (*Pan-tao-t'i Yen-chiu-so*), AS, Peiping.
Institute of Traditional Drugs (*Chung-yao Yen-chiu-so*), AMS.
Institute of Veterinary Medicine (*Shou-i Yen-chiu-so*), Harbin, also known as the All-China Veterinary Scientific Research Institute, Harbin Veterinary Research Institute, Northeast Veterinary Research Institute.
Kirin University (*Chi-lin Ta-hsueh*), Ch'ang-ch'un.
K'un-ming Astronomical Observatory (*K'un-ming T'ien-wen-t'ai*), K'un-ming, also known as the Feng-huang-shan (Phoenix Hill) Observatory.
Laboratory of Bacteriology, Peiping and Wu-han.
Laboratory of Hydraulic Engineering (*Shui-kung Yen-chiu-shih*), AS, Peiping.
Laboratory of Theoretical Physics (*Li-lun Yen-chiu-shih*), IAE, Peiping.
Laboratory of Zoology, Peiping.
Lanchou University (*Lan-chou Ta-hsueh*), Lan-chou.
Lo-hsueh High Mountain Laboratory (*Lo-hsueh Kao-shan Shih-yen-shih*), Lo-hsueh near Tung-ch'uan, also known as the Mt. Lo-hsueh Cosmic Ray Observatory.
Meteorological Society of China (*Chung-kuo Ch'i-hsiang Hsueh-hui*).
Ministry of Agriculture (*Nung-yeh Pu*).
Ministry of Chemical Industry (*Hua-hsueh Kung-yeh Pu*).
Ministry of Coal Industry (*Mei-t'an Kung-yeh Pu*).
Ministry of Communications (*Chiao-t'ung Pu*).
Ministry of Education (*Chiao-yu Pu*).
Ministry of Geology (*Ti-chih Pu*).
Ministry of Marine Products (*Shui-ch'an Pu*).
Ministry of Metallurgical Industry (*Yeh-chin Kung-yeh Pu*).
Ministry of Petroleum Industry (*Shih-yu Kung-yeh Pu*).
Ministry of Public Health (*Wei-sheng Pu*).
Ministry of Water Conservancy and Electric Power (*Shui-li Tien-li Pu*).
Nankai University (*Nan-k'ai Ta-hsueh*), Tientsin.
Nanking Engineering College (*Nan-ching Kung-hsueh-yuan*), Nanking.
Nanking University (*Nan-ching Ta-hsueh*), Nanking.
Northeast (Polytechnical) Engineering College (*Tung-pei (To-k'o-hsing) Kung-hsueh-yuan*), Mukden.
North China Agricultural Research Institute, Peiping, also known as the Northwest Agricultural Research Institute (*Hsi-pei Nung-yeh K'o-hsueh Yen-chiu-so*), Peiping.
Northwest Institute of Zootechnics and Veterinary Medicine (*Hsi-pei Ch'u-mu Shou-i Yen-chiu-so*), Lan-chou.
Pai-chia Special Disease Research Institute, Pai-chia.
Peiping Astronomical Observatory (*Pei-ching T'ien-wen-t'ai*), Peiping.
Peiping Glass Factory (*Pei-ching Po-li Ch'ang*), Peiping.
Peiping Iron and Steel Research Institute (*Pei-ching Kang-t'ieh Yen-chiu-so*), Peiping, also known as the Institute of Ferrous Metallurgy.
Peiping Medical College (*Pei-ching Hsieh-ho I-hsueh-yuan*), Peiping.
Peiping Planetarium, Peiping.
Peiping Radio-Astronomical Observatory, Peiping.
Peiping Scientific Research Institute for Nonferrous Metals.
Peiping Tumor Hospital (*Pei-ching Chung-liu I-yuan*), Peiping.
Peiping University (*Pei-ching Ta-hsueh*), Peiping.
Power Laboratory of the AS (*Tung-li Yen-chiu-shih*), Peiping.
Purple Mountain Observatory (*Tzu-chin-shan T'ien-wen-t'ai*), Nanking, with branches at Tsingtao and Tientsin.
Research Institute of Chinese Traditional Medicine (*Chung-i Yen-chiu-yuan*), Peiping, also known as the Academy of Traditional Chinese Medicine, and also as Research Institute of Chinese Medicine.
Research institutes of the Ministry of Marine Products at Canton and Shanghai.
Research Institute of Pharmacology, Shanghai.
Shanghai Camera Plant (*Shang-hai Chao-hsing-chi Ch'ang*), Shanghai.
Shanghai Research Institute of Pharmaceutical Chemistry of the Ministry of Chemical Industry.
Shanghai Scientific and Industrial Instrument Research Institute (*Shang-hai I-ch'i I-piao K'o-hsueh Yen-chiu-so*), Shanghai.
Shangtung College of Oceanography (*Shan-tung Hai-yang Hsueh-yuan*), Tsingtao.
Shen-yang National Chemical Research Institute, Mukden.
She Shan Astronomical Observatory, Shanghai, also known as the Zose Observatory.
Silt Research Laboratory (*Ni-sha Yen-chiu-shih*), Cheng-hsien.
State Bureau of Surveying and Cartography (*Kuo-chia Ts'e Ts'e-hui Tsung-chu*), Peiping, with branches at Harbin and Sian.
(State) Scientific and Technological Commission (*K'o-hsueh Chi-shu Wei-yuan-hui*).
Swatow Photographic and Chemical Plant, Swatow.
Talai Works, Peiping.
Tsinghua University (*Ching-hua Ta-hsueh*), Peiping.
Water Conservancy Society of China (*Chung-kuo Shui-li Hsueh-hui*).
Wu-han Geophysical Observatory (*Ti-ch'iu Wu-li Kuan-hsiang-t'ai*), AS, near Hankow, commonly known as the Institute of Upper Atmosphere Physics.
Wu-han University (*Wu-han Ta-hsueh*), Wu-ch'ang.
Zikawei Observatory (*Hsu-chia-hui T'ien-wen-t'ai*), Shanghai.
Zose Observatory (*She-shan T'ien-wen-t'ai*), Shanghai, also known as the She Shan Astronomical Observatory.

B. Physical sciences and mathematics

1. Chemistry and metallurgy

a. General

(1) *Capabilities and trends* — Communist China has a very low capability in both applied and fundamental research in chemistry and metallurgy. The greatest emphasis is on the applied aspects, in order to meet the goals of the 12-year program; however, the shortage of qualified scientists and adequate facilities and equipment hampers work in these fields. The emphasis on applied research is retarding the expansion of fundamental research. Nevertheless, this emphasis is expected to continue because of the great desire to achieve a wide industrial base in the earliest possible time. The chief weakness of Communist China in chemical and metallurgical research is a shortage of scientists and technicians.

The Soviet Union has been giving considerable assistance to Communist China by educating Chinese students at U.S.S.R. universities, by furnishing some laboratory equipment, and by providing scientists and engineers as consultants in the development of Chinese research projects and industries. Chinese research chemists are well supplied with Soviet and Western technical literature, much of which is translated and abstracted to keep them up-to-date on foreign developments. These include monthly journals of translations on chemistry and petroleum and fuels, plus a monthly index of foreign chemical papers. Delegations of Chinese scientists have also traveled to the U.S.S.R. to consult with Soviet scientific leaders.

There is no area of chemical or metallurgical research in which Communist China has any outstanding strength. Their exploitation of Western-trained scientists who have returned to the country indicates a well devised plan. This group, still the core of their scientific manpower, is composed of older intellectuals who were trained in Europe and the United States, plus many younger men who were in training during and after the revolution and who have since returned to China. While many of these scientists are politically suspect, the government has made maximum use of their talents whenever possible.

There is no evidence of any original fundamental research in physical chemistry in Communist China. The major effort has been to use physical chemistry as a tool for applied science and industrial processes. The study and use of physical chemistry has been stimulated by the need for methods of chemical analysis of raw materials and products, and for the development and manufacture of industrially important materials.

In organic chemistry, the Communist Chinese are making progress in applied research directed toward the utilization of their natural resources. The major effort is in research on plastics, synthetic rubber, and synthetic fibers, but the work is not original and follows that of the West.

Little or no basic research is being done in Communist China on conventional fuels. The majority of their applied effort is on improving existing petroleum extraction and refining processes, and on developing synthetic fuels processes. Very limited information is available on Communist Chinese explosives research.

In the field of inorganic chemistry, research is generally devoted to adapting known methods for quality control for materials in production or under development. Rare earths, which occur in several ore deposits, have been the subject of some research, closely resembling published Western research.

In chemical engineering, the small amount of information available indicates that significant programs are being undertaken by the Communist Chinese, but notable progress is not expected before the next five years. Some indications of advanced work are found in the application of analog computers to chemical engineering problems, and in the use of radiation to effect chemical reactions.

(2) *Background and organization* — Prior to 1949, Chinese research in chemistry was carried on at the universities, at government-operated industrial research institutes and, to some extent, at privately owned laboratories. Fundamental research was conducted at research institutes, including an Institute of Chemistry (*Hua-hsueh Yen-chiu-so*), Shanghai, under the administration of the China Academy of Sciences (*Academia Sinica*), founded in 1928 in Nanking and patterned after its Soviet counterpart. In addition, the National Academy of Peiping (Peking), founded in 1929, operated similar research institutes. Little real progress could be achieved under the constant harassment of wars and revolution, although limited research in pure science was carried on in private institutions and missionary colleges, as well as at the academy institutes. Also, some aid from the West encouraged the development of Chinese science and technology. In Manchuria, the Japanese, while in control, built substantial research facilities, which were almost entirely dismantled by the Soviet armed forces at the end of World War II. The attempt after World War II to reorganize Chinese research organizations was disrupted by the Communist revolution.

Since taking over the country, the Communists have reorganized and expanded the Chinese Academy of Sciences to include all the institutes formerly under the National Academy of Peking and many others; policy formulation affecting all scientific research programs has been placed under strict, centralized government control.

The AS is the most important overall research organization in Communist China. Its responsibilities include both basic and applied research, although in recent years the major emphasis has been in support of industrial activities sponsored by the various ministries. Many of the leading research institutes are a part of the academy, and it is apparent that these play a key role in the technological development of China; some actually engage in serial production in some fields.

The effort toward industrialization in Communist China has necessitated heavy emphasis on both technological development and capital construction, especially in the iron and steel and manufacturing industries. Most of China's qualified scientists, including many of those who have received advanced training in the U.S.S.R. or in the West until recently, have been engaged in supporting these industries. Consequently, only a limited number of the country's chemists and metallurgists have been engaged in basic research.

Chemical research is done at institutes under the Department of Physics, Mathematics and Chemistry of the academy and its branches, at universities under the Ministry of Education (*Chiao-yu Pu*), and at industrial plants and laboratories of the industrial ministries. Industrial plant laboratories and research facilities under the ministries are apparently limited to the development of analytical procedures for process control, and solving production problems.

The design and planning offices of the Ministry of Chemical Industry (*Hua-hsueh Kung-yeh Pu*) are expected to be primarily responsible for developing the country's chemical industry, in order for it to fulfill the country's grandiose goals. The Chemical Industry Design Institutes (*Hua-hsueh Kung-yeh She-chi-yuan)* in Peiping and Shanghai and branch institutes coordinate design efforts and delegate specific types of problems to avoid duplications. One of their goals is the design of both processes and equipment to conserve metal, which is expected to be in short supply for some time. A lack of materials is the factor limiting the scope of current capital construction.

Both fundamental and practical research, designed to advance chemical production, is being conducted at Communist Chinese universities. At Fu-Tan University (*Fu-tan Ta-hsueh*) in Shanghai, students in the Chemistry Department operate a small plant which monthly turns out several tons of ammonium persulfate. Students at Peiping University (*Pei-ching Ta-hsueh*) designed an experimental plant for tetraethyl lead. Based on this experience, a factory was designed and is now operating near Peiping. Universities are often well equipped with modern laboratory apparatus for science teaching. There is some doubt, however, that the chemistry faculties are allotted much time or equipment for chemical research in depth.

Factors limiting chemical engineering research are the shortage of experienced chemical engineers, inadequate facilities, and lack of scientific equipment and supplies. The equipment situation is improving gradually with the large purchases from abroad. The shortage of trained chemical engineers is being improved somewhat by the return of a number of highly trained Chinese scientists and technologists in recent years, and by the emphasis on training. Moreover, Soviet assistance in the form of equipment, entire plants, and manpower is also improving the situation.

Another organization, now under government control, is the Chemical Society of China (*Chung-kuo Hua-hsueh Hui)* founded in 1932 and reorganized by the Communists in 1951. Its main function appears to be the publication of three chemical journals: the *Hua-hsueh Shueh-pao* (Journal of Chemistry), the *Hua-hsueh Tung-pao* (Chemical Bulletin) and the *Hua-hsueh T-pao* (Journal of Chemical Translations). The society is headed by Dr. Yang Shih-hsien, president of Nankai University (*Nan-k'ai Ta-hsueh*), Tientsin, and one of China's leading organic chemists. In 1957 the society was reported to have 4,000 members.

Problems of improving metals processing techniques and equipment, and of judiciously employing the less abundant metals to make available a somewhat greater variety of engineering materials primarily concern Chinese metallurgists. Expansion and modernization of the nonferrous producing industries, similarly, are receiving emphasis.

The Ministry of Metallurgical Industry (*Yeh-chin Kung-yeh Pu*), which governs production of both ferrous and nonferrous ores and metals, maintains research and design facilities whose functions are directly related to the planning, construction, and modernization of metallurgical plants and equipment. Two such facilities are the Ore Dressing Research Institute and the Nonferrous Metals Design Institute, both of which are mainly concerned with applied problems.

b. MAJOR RESEARCH AND DEVELOPMENT BY FIELD

(1) *Physical chemistry* — There is no evidence of any original, fundamental physical chemical research in Communist China. The study and use of physical chemistry as a tool for applied sciences and industrial processes, has been stimulated by the need for methods of chemical analysis of raw materials and products and for the development and manufacture of economically and industrially important materials.

(a) SPECTROSCOPY — The First All-China Conference on Spectroscopy was held in 1958 at Peiping, with a delegation of Soviet spectroscopists attending. Following the example of early Soviet policies, the Chinese Communists apparently are emphasizing the development of emission spectroscopy for metals analysis. Some attention is also given to ultraviolet and infrared spectrophotometry in the analysis of petroleum products and pharmaceuticals. Research is applied, for the most part, with little work being done in spectroscopic theory or fundamental experimentation. With help from visiting Soviet specialists, the Chinese are apparently embarked on a program of expansion in this field to provide precise, rapid means for the analysis of their industrial products and as a tool for research; however, the number of qualified Chinese spectroscopists available to conduct research is probably small.

The Institute of Applied Chemistry (*Ying-yung Hua-hsueh Yen-chiu-so*), of the AS, Ch'ang-ch'un, where most of the work on spectroscopy is conducted, has a well-equipped atomic and molecular spectra laboratory. Most spectroscopic research is actually spectro-analytical work applied to the analysis of mineral ores, alloys, and steels, and infrared spectrum analysis of organic compounds. A few physical chemists, mainly faculty members of Peiping University, are publishing theoretical papers on the quantum-chemical treatment of molecules, related to the understanding and interpretation of experimental results of molecular spectroscopy.

The large chemical and metallurgical institutes and some universities are equipped with spectroscopic equipment imported from the U.S.S.R. and other bloc countries. When possible, Western equipment is also obtained by the Chinese. Copies of Soviet instruments are being produced at the Institute of Optics and Precision Apparatus and Instruments (*Kuang-hsueh Ching-mi Chi-hsieh I-ch'i Yen-chiu-so*), AS, at Ch'ang-ch'un, with guidance from the U.S.S.R., but there is no indication that the Chinese have a capability for the design of original spectrographic equipment of advanced types. Research is claimed to be underway on the construction of a ruling machine to produce diffraction gratings used in precise spectroscopic apparatus.

(b) CHEMICAL KINETICS AND CATALYSIS — Studies in chemical kinetics and catalysis are emphasized in connection with the petroleum industry and with the synthesis of organic compounds. Organic catalysis studies have been conducted in the Physical Chemistry Department of Peiping University in cooperation with the Institute of Petroleum (*Shih-yu Yen-chiu-so*), AS, Dairen. Combustion kinetics research related to studies of gas combustion engines is conducted at the Department of Technical Sciences of the AS. At Peiping University studies have been on the poisoning and depoisoning of catalysts. Studies of catalysts are one of the main areas of application of adsorption and surface chemistry research. The other application of the Chinese Communists' research in surface chemistry is directed toward the development of techniques of chromatographic adsorption used mainly for the analysis of organic compounds.

(c) ELECTROCHEMISTRY AND THERMOCHEMISTRY — Research in electrochemistry and thermochemistry, dealing mainly with analytical aspects of solution chemistry, is being conducted at Nanking University, the Institute of Chemistry of the AS, Peiping, and Peiping University. At the latter, emphasis is on the study of industrially important techniques of electrolytic deposition and battery design and manufacture.

(d) CRYSTALLOGRAPHY — Growth and purification of materials useful as components for electronic equipment or optical instruments has stimulated work in crystallography, especially crystal growth techniques. Semiconductor research and development receives special attention, with emphasis being placed on the technology of germanium and silicon. Theoreticians are being encouraged to attack some of the problems of solid state work, and are doing so to a limited extent by means of statistical thermodynamics. Limited work in phase equilibrium and phase change studies important to materials research is being conducted by crystallographers and thermodynamicists.

(2) *Organic chemistry*

(a) PHARMACEUTICAL CHEMISTRY — The development of a pharmaceutical industry was one of the early research goals of the Chinese Communists. Applied research on pharmaceuticals was undertaken in the early 1950's in order to duplicate known products and adapt production processes to cheap, available raw materials. The Chinese remain far behind other modern countries in their antibiotics research. Nevertheless, by 1958, they had achieved some of their limited research goals as evidenced by the appearance on the world market of Chinese chemical and pharmaceutical products such as vitamins, sulfa drugs and some antibiotics.

Recent published research indicates a widening interest in the synthesis and study of organic compounds of possible medicinal value. At the Institute of Organic Chemistry (*Yu-chi Hua-hsueh Yen-chiu-so*), AS, in Shanghai, work is underway on the synthesis and study of antibiotics such as streptomycin, penicillin, and their derivatives. Other research institutes, such as the Research Institute of Pharmacology and Institute of Materia Medica (*Yao-wu Yen-chiu-so*), AS, Shanghai, conduct similar fundamental and applied research on pharmaceutical products, especially the antibiotics.

The study of natural products such as alkaloids, vitamins, and hormones has also received increasing attention in Communist China. Papers by various authors have appeared, concerned with the preparation and study of medically useful compounds from herbs and agricultural products such as soybeans. Lu Jen-jung and Chu Tzu-ching, of Lanchou University (*Lan-chou Ta-hsueh*), Lan-chou, and, with apparent affiliations at the Institute of Organic Chemistry and other research facilities, were awarded a Third Class Science Prize in Chemistry in 1957 for their work on the isolation and identification of alkaloids, possibly having anesthetic, analgesic, tranquilizing, or other useful effects. In spite of their strong interest in traditional herb medicines, Chinese chemists are not known to have extracted any new drugs from them.

Some work has also been published on the synthesis and study of complex heterocyclic compounds and organoantimony compounds in a search for biologically active materials useful in treating schistosomiasis, tuberculosis, malaria, and other endemic diseases in the Far East. Members of the staff of the Institute of Organic Chemistry, in collaboration with the Shanghai Research Institute of Pharmaceutical Chemistry of the Ministry of Chemical Industry, are synthesizing complex benzene derivatives in a search for carcinostatic agents, following similar Western research.

(b) PETROLEUM CHEMISTRY — Research in this field has been resumed at reorganized and renamed installations originally established by the Japanese during their occupation of Manchuria, such as the Institute of Petroleum at Dairen. Work is underway on the analysis of crude petroleum by gas chromatography, distillation and spectroscopy. Numerous hydrocarbons have been identified in petroleum by these means, largely in imitation of previously published work. Shale oil processing is also under investigation, including work on flash vaporization and purification by chromatographic adsorption on silica gel of inorganic components, such as sulfur and other impurities. Other research is in progress on the study of catalytic agents for producing synthetic gasoline. The Chinese have claimed success in the development of a satisfactory iron catalyst to replace the expensive and less readily available cobalt catalyst used in the synthesis of gasoline by the Fischer-Tropsch process, a problem known to have been under investigation for several years. Other catalysis research is in progress on catalytic dehydrogenation and hydrogenation of hydrocarbons, new catalytic materials, and the effects of mixed catalysts on the speed of reaction and yield of desired products. Most of this research is in support of the petroleum and petrochemical industry, and shows little originality.

(c) ORGANOMETALLIC CHEMISTRY — A small amount of research is underway in organophosphorus chemistry and other organometallic compounds. Dr. Yang Shih-hsien, president of Nankai University in Tientsin, is reputed to be the only important Chinese chemist interested in organophosphorus chemistry. His published research has been on the synthesis of plant growth regulators and insecticides. Other workers have published on the synthesis and study of organophosphorus, organoarsenic, and organoantimony compounds for possible use as insecticides, medicines, and reagents useful in chemical analysis.

(d) DYE CHEMISTRY — Dye chemistry has received some attention but most research is apparently related to production problems. The Chinese claim to have produced several dyes and dye intermediates new to China in the past few years. Indanthrene dyes and new dyes for synthetic fibers are reported under study at the Shenyang National Chemical Research Institute, Mukden. Evidence of fundamental dye research is not apparent.

(3) *Inorganic chemistry*

(a) ANALYTICAL CHEMISTRY — Most published research by Chinese analytical chemists has been on the development of methods of analysis for metals, industrial chemicals and petroleum products. Recent work indicates Chinese awareness of modern methods of analysis, such as paper chromatography, polarography, complexometric titration, and spectroscopy. Published work has appeared in the analysis of steel and nonferrous metals, uranium and rare metal analysis, the analysis of hydrocarbons in petroleum, and the testing of pharmaceutical products. The work appears to be devoted primarily to adapting known methods for quality control of materials in production or under development.

(b) RARE EARTH CHEMISTRY — China is known to possess several ore deposits bearing thorium and the rare earths, as well as uranium. In addition, the large Pao Tao iron ore deposits in Inner Mongolia are reported to contain significant amounts of rare earths. It is apparent that, in their drive to utilize the natural resources of the country, the Chinese are attempting to develop a pure rare earth industry, most likely in connection with their nuclear energy program.

Rare earth research is apparently underway at the Inistitute of Chemistry of the AS, Peiping, and at the Institute of Applied Chemistry (*Ying-yung Hua-hsueh Yen-chiu-so*) at Ch'ang-ch'un. In 1959 the preparation of several spectroscopically pure rare earths was claimed in the Chinese press. Extraction and isolation of rare earths from Pao Tao furnace slag were also reported. However, published research appears to be of a routine nature, principally concerned with spectroscopic analysis, chromatographic analysis, and the separation of rare earths, and appears to repeat known methods and techniques. Research is also claimed to be underway on the pilot plant production of pure rare earth compounds, such as rare earth borides for use in electronics applications, rare earth sulfides as fire retardant materials, and rare earth optical glass. Aid and advice in setting up their rare earth spectral analysis program has been supplied to the Chinese by visiting Soviet experts in the past few years under the Sino-Soviet cooperative program. The Chinese capability for research in rare earths is rising rapidly, although it is still far behind the scientifically advanced nations and is contingent upon Soviet assistance.

(4) *Macromolecular chemistry* — There is no significant research or any single outstanding polymer research chemist or facility in all of China. Work in this field has been incipient in the period 1958–60. Physical and chemical structure studies, polymerization techniques and laboratory pilot studies are made on nylon 6, nylon 66, nylon 11, methylmethacrylate, polyvinylchloride, acrylonitrile, phenol-formaldehyde, tetrafluoroethylene, and silicones. Low-pressure polyethylene polymerization experiments are being conducted. This work is quite routine and duplicates similar work done in the West two to fifteen years ago.

(a) SYNTHETIC FIBERS — China has produced rayon fibers and, as a consequence, Chinese scientists are doing research on bagasse, corncobs, cotton stems, cornstalks and bran as sources of cellulose. Synthetic fiber research is on polymerization of monomers and development of fiber forming techniques for polyamides, polyacrylonitrile, polyvinylchloride and ethyleneglycol terephthalate. This research follows that done in the West.

(b) SYNTHETIC RUBBER — Very little research, basic or applied, is being done on the newer types of synthetic rubber polymers; however, production of synthetic rubber was inaugurated at Lanchou Chemical Combine (using petroleum derivatives) in mid-1960. The Kirin Combine is also preparing to go into production. Most manufactured rubber goods are made from imported natural rubber and are of rather poor quality. There have been attempts, although todate unsuccessful, to develop a domestic supply of natural rubber through cultivation of rubberbearing trees and plants. Communist China has a rubber shoe and auto tire manufacturing capacity greater than their availability of raw rubber; as a result, these facilities appear to be operating at only a portion of their capacity.

Despite the fact that China only recently has entered into polymer research, scientists are working on the most newly developed chemical compositions and polymerization techniques. Typical of this is the Ziegler low pressure polymerization technology, silicone resin and polyester resin research.

(5) *Chemical engineering* — Much of the total research and development effort in chemical engineering is conducted by the larger industrial plants and is aimed at equipment and process improvements to advance technology and increase production. Research and development efforts not intimately tied in with the operation of plants are carried out in institutes of the AS, design and planning offices and research institutes of the Ministry of Chemical Industry (*Hua-hsueh Kung-yeh Pu*), institutes of other industrial ministries, and also at colleges and universities. Little information is available on Communist Chinese research and development efforts in chemical engineering; however, fairly extensive participation in the mass and heat transfer conference held in Nanking in July 1959, indicates that significant programs are underway.

There are some indications of work in the more advanced aspects of chemical engineering. Research at the Dairen Engineering College (*Talien Kung-hsueh-yuan*), Dairen, has dealt with the use of direct current analog computers in chemical engineering (chemical kinetics, unsteady state heat transfer, rectification, absorption, and cooling curves of steel plates). With Soviet aid, high vacuum and ultrasonic techniques have been mastered rapidly. Diffusion pumps able to produce vacuums of 4×10^{-6} millimeters of mercury are manufactured by the Yung-Ku Machinery and Equipment Plant. Also available, based on the use of ultrasonic techniques, are Chinese-produced defect detectors, geological prospecting instruments, and mechanical processing machines. At the Institute of Atomic Energy (*Yuan Tzu Neng Yen-chiu-so*), IAE, Peiping, of the AS, benzene hexachloride has been synthesized through the use of radiation. The claim has been made that this method could be used commercially.

(a) FERTILIZERS — Because of the urgent need for fertilizers, that commodity was given top priority in 1958, and has consumed most of the available chemical engineering talent. The Chinese have built many small fertilizer plants, which are to serve as a training ground for personnel to staff larger plants to be built later. Key equipment for the small plants is being designed and fabricated by the Dairen Chemical Plant (*Ta-lien Hua-kung-ch'ang*), Dairen, and the Yung Li Factory, near Nanking. This cooperative group has been expanded into a college of design, with a great increase in the number of design engineers. The plan calls for 2,000 small nitrogen fertilizer plants, each making only 2,000 tons of ammonia. The bulk of the end product is to be ammonium bicarbonate, which is claimed to be the most needed fertilizer. The processing of nitric acid, a component of the better nitrogen fertilizers, is not being undertaken.

(b) NITRIC ACID — The Dairen Engineering College and the Dairen Chemical Plant in 1957 jointly developed a two-stage nitric acid from ammonia oxidation process designed to reduce the loss of platinum catalyst. A chrome steel or cobalt oxide screen was placed below the platinum alloy screen. The conversion of ammonia on the top screen amounted to 90%, with conversion to 97–98% taking place on the non-platinum screen. By this technique, the loss of platinum was reduced 20% and the cost of material by 70%. A lack of materials is likely to prove a greater problem in the development of the chemical industry than insufficient technology.

(6) *Explosives and propellants*

(a) EXPLOSIVES — In spite of a very illustrious beginning in explosives, dating from the 10th century, there is no indication that either explosives or propellant research in China has kept pace with that in the more progressive countries in the world. Very limited information is available on Chinese efforts in these fields. Explosives research is scheduled to be undertaken at the Institute of Applied Chemistry, AS, at Ch'ang-ch'un.

(b) PROPELLANTS — A jet propulsion expert, Dr. Chien Hsueh-sen, former head of the nonmilitary Guggenheim jet propulsion center at the California Institute of Technology, returned to China in mid-1955 and is now director of the Institute of Mechanics (*Li-hsueh Yen-chiu-so*) of the AS, Peiping. Many of the Chinese co-workers of Dr. Chien while he was in the United States also returned to China at about the same time. With this nucleus of jet propulsion capability, Chinese activity in the missile propellant field is anticipated; however, the billion-ton boron mineral deposit containing about 4% boron, which the Chinese claim to have found at Tsaidam Basin, probably will be exploited for propellant use by the Soviets rather than by the Chinese.

(7) *Metallurgy* — Communist China has made no significant contributions to metallurgical science or engineering. Since approximately 1952, Chinese metallurgists have directed most of their effort toward solving the technological problems associated with industrialization, including the establishment of a large-scale metallurgical training program. Within the past several years, an increasing amount of basic metallurgical research has been conducted; however, with the exception of certain studies in the field of metal physics, most of the published research lacks originality.

(a) METAL PHYSICS — Research on metal physics in Communist China is led by Dr. Ko T'ing-sui, a Western trained specialist now at the Institute of Metals (*Chin-shu Yen-chiu-so*) in Mukden. His activities involve studies of internal friction in various metals and alloys, and he has attempted to offer explanations for such mechanisms as diffusion, austenite decomposition, and the existence of dislocations. Related work, including studies of the physics of strength of metals, is also being conducted within the Department of the Physics of Metals at Kirin University (*Chi-lin Ta-hsueh*), Ch'ang-ch'un, formerly the Northeast People's University; at the Peiping Iron and Steel Research Institute (*Pei-ching Kang-t'ieh Yen-chiu-so*), also known as the Institute of Ferrous Metallurgy (see FIGURE 76–2); and at the Department of Physics of the Metallic State at Peiping University. Most of the published research in metal physics indicates a high degree of competence, and studies in the subfield of internal friction compare favorably in quality to those of the West. Chinese work on alloy theory has provided little new information. Another area of basic studies apparently receiving increasing attention is that of the kinetics of phase transformations. The work has been limited to steel and has not resulted in any unusual findings, although published research indicates a generally rising competence.

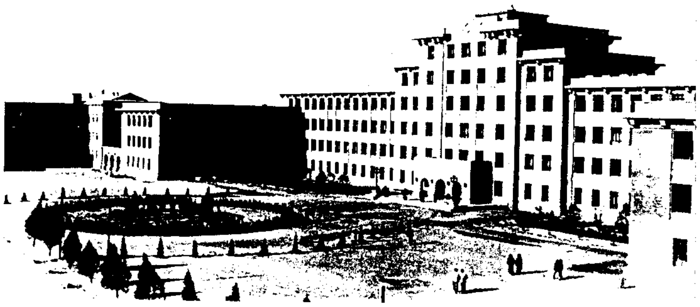

FIGURE 76–2. PEIPING IRON AND STEEL RESEARCH INSTITUTE

(b) IRON AND STEEL — A substantial amount of supporting research has been accomplished in connection with the development of China's iron and steel industry. Developmental work to permit the utilization of a fluorine containing iron ore, for example, has involved studies of ore beneficiation, investigations of the effects of fluorine on the blast furnace process, and the determination of adequate furnace refractories. Various methods also have been studied for enriching other low-grade iron ores.

Metallurgists specializing in steelmaking have adapted the side-blown converter for use with pig iron of high phosphorus content. Investigations of numerous other elements of steel technology are continuing in an effort to improve quality and production rates through modernization of processes and equipment. While considerable progress has been made in raising the general level of iron and steelmaking efficiency, there are still wide variations in practices, partially due to the antiquated production facilities existing in some plants.

Communist China is currently evaluating its needs for alloy steels in an attempt to standardize the production and quality of those compositions needed by industry and to use available alloying metals most economically. Following a Soviet suggestion, Chinese metallurgists have been studying the iron-tungsten-silicon alloy system for its possible application as a substitute for more costly, imported nickel and cobalt-containing high temperature alloys.

The importance of electrical steels and materials for electronic applications to China's technical progress is reflected in the research programs of several of the more important metallurgical and physics research facilities. Most of the better known magnetic ferrite materials and permanent magnet alloys have been reviewed, primarily for familiarization and probably with manufacture as the eventual goal. Research has been done on vacuum treating of silicon steel for electrical applications.

(c) NONFERROUS METALS — Chinese metallurgists are also working to increase the output of most of the more common nonferrous metals, especially aluminum. The Peiping Scientific Research Institute for Nonferrous Metals is studying various factors of aluminum extraction technology, including the adaptation of Soviet procedures. Some routine work concerning aluminum alloy systems and their application is being done at the Department of Light Metals of the Northeast (Polytechnical) Engineering College (*Tung-pei (To-k'o-hsing) Kung-hsueh-yuan*), Mukden.

Recently published Chinese reports claim successes in numerous specialized fields, including an improved method of zone refining to produce metals of high purity, a procedure for the extraction of ultra pure nickel, and various rare earth recovery techniques and means for analysis. While, in themselves, such claims are difficult to assess, they indicate the diversity of present metallurgical research activities in Communist China.

(d) NUCLEAR METALLURGY — Within the last three years, the Chinese increasingly have emphasized metallurgical research with possible significance in nuclear energy. Their publications on stainless steel appear to be more frequent than the technological level of the country warrants. The investigations of boron in steel could be a direct result of the use of boron steel for control rod purposes in Chinese nuclear reactors.

There has been a steady increase in Chinese papers relating to the theories of metals applicable to problems of radiation damage. Undoubtedly, the Chinese have been troubled with lack of dimensional stability of fuel elements of their first reactor since it began operation in 1958. Although they have never published on uranium, it is believed that they have obtained substantial assistance on this subject from foreign publications, and have directed their research program on other metals to the solving of problems peculiar to nuclear fuel elements. Highly academic Chinese research on lattice defects, ordering, preferred orientation, and the solid state phenomena could be explained perhaps more easily on this basis than on any other.

In general, although clearly identifiable Chinese research in nuclear metallurgy is extremely rare, there is a pronounced emphasis on some very necessary background techniques, as well as on some of the vital structural materials. Nuclear metallurgy in China is currently about on the same level as that in Poland, but the basis for very rapid advances in the very near future is being carefully prepared in China. It is believed that the Chinese have the industrial capability to produce their own uranium metal fuel elements at the present time without depending on the U.S.S.R. as in the recent past.

c. SIGNIFICANT RESEARCH FACILITIES — FIGURE 76–3 shows the location of facilities engaged in scientific research and development in Communist China.

Dairen Engineering College (*Ta-lien Kung-hsueh-yuan*), *Dairen*—Deputy director: Chao Chune-cha, 1958. Is probably under the Ministry of Chemical Industry. Also called Dairen Institute of Technology or Dairen Industrial College. Has a Department of Chemical Engineering and a Department of Chemistry. Participated in the All-Chinese Conference on "industrial energy, heat transfer, and mass transfer," held in Nanking in July 1959.

Fu-Tan University (*Fu-tan Ta-hsueh*), *Shanghai*—Director: Chen Wang-tao since 1955. Founded in 1903, this institution was reorganized in 1952 when the literature and science schools of fifteen universities in the vicinity of Shanghai were amalgamated. It is subordinate to the Ministry of Education. Research is conducted on problems related to industrial production. Current work includes synthesis of organosilicon compounds, analysis of metals, corrosion studies. By 1959, a chemistry building had been constructed, laboratory equipment had been increased, and there were many scientific projects underway.

Institute of Applied Chemistry (*Ying-yung Hua-hsueh Yen-chiu-so*), *Ch'ang-ch'un*—Director: Dr. Wu Hsueh-chou since 1953. Founded in 1953, this institute is subordinate to the AS. Applied research is under way in five laboratories devoted to inorganic, organic, analytical, synthetic, and physical chemistry. Current research is aimed at the development and improvement of industrial processes. Work underway in 1958 included the study of natural products such as soybean albumin and tung oil for use in plastics and resins; natural lacquers; analytical methods; sulfuric acid manufacture; catalysis. In 1958, the institute claimed to have successfully separated eleven spectroscopically pure rare earth oxides and to have set up a pilot plant for rare earth production. There were 180 employees at this institute in 1958. Equipment is said to include spectrographic apparatus imported from the U.S.S.R., Soviet bloc countries, and the West.

Institute of Physics (*Wu-li Yen-chiu-so*), *under the Department of Physics, Mathematics, and Chemistry, AS, Peiping*—Director: Dr. Shih Ju-Wei. For information on this institute, see under the Physics Subsection.

Institute of Chemistry (*Hua-hsueh Yen-chiu-so*) *of the AS, Peiping*—Director: probably Hua Shou-chun, since 1957. Deputy director: Liu Ta-kang. Current research includes polymer studies, raw materials for synthetic fibers, pharmaceuticals organosilicons, and organic microanalysis. This institute has five technical sections for research on high polymers, organic chemistry, inorganic chemistry, analytical chemistry, and physical chemistry—the last section has a newly equipped thermodynamics laboratory. This institute has a staff of about 330, including 20 senior researchers and directors, 20 junior researchers, and 180 technicians.

Institute of Metallurgy and Ceramics (*Yeh-chin T'ao-ts'u Yen-chiu-so*), *Shanghai*—Director: Chou Jen. Subordinate to the Department of Technical Sciences of the Academy of Sciences, this institute has two departments of interest, one for Chemical Metallurgy and another for Physical Metallurgy. Two branches also exist, one at K'un-ming, which was established in 1958, and another at Changsha, which specialize in problems of ore dressing. Most of its activities are in direct support of industry; consequently, little basic research has been undertaken; however, it has a sizable ferrous research program, and some nonferrous work is in progress.

Institute of Metals (*Chin-shu Yen-chiu-so*), *Mukden*—Director: Dr. Li Hsün, since 1952. Subordinate to the AS, this institute has five divisions: Metallurgical Chemistry, Metals Processing, Physical Metallurgy, Metal Physics, and Refractories. It is noted for iron and steelmaking research, most of which has been conducted for the Anshan steel complex. Basic research on internal friction in metals is high in quality. The total staff numbers about 500, of whom approximately 150 are engaged in research.

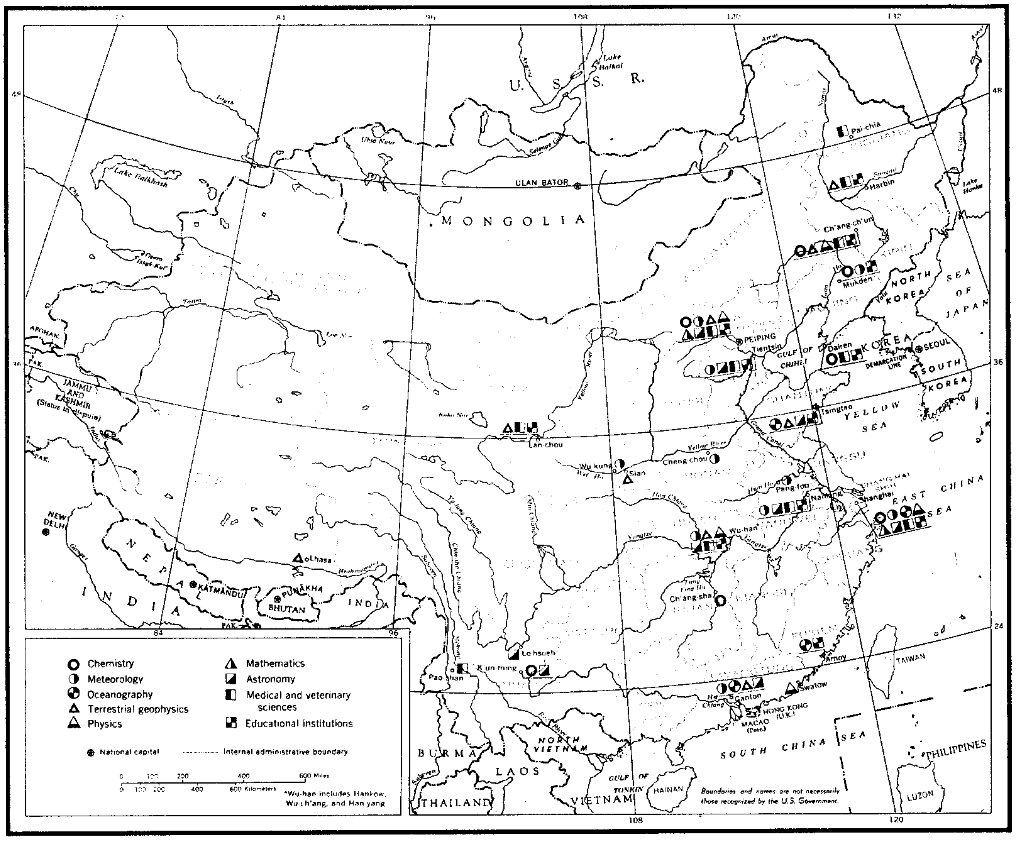

FIGURE 76–3. LOCATIONS OF SCIENTIFIC AND TECHNICAL ACTIVITIES, 1960

LOCATION—SIGNIFICANCE
CHEMISTRY
CH'ANG-CH'UN (43°52′N., 125°21′E.)—Institute of Applied Chemistry, AS.
CH'ANG-SHA (28°12′N., 112°58′E.)—Branch of the Institute of Metallurgy and Ceramics.
DAIREN (38°55′N., 121°39′E.)—Dairen Chemical Plant; Institute of Petroleum, AS.
K'UN-MING (25°04′N., 102°41′E.)—Branch of the Institute of Metallurgy and Ceramics.
MUKDEN (41°48′N., 123°27′E.)—Institute of Metals, AS; Shenyang National Chemical Research Institute.
PEIPING (39°56′N., 116°24′E.)—Chemical Industry Design Institute; Chinese Academy of Sciences; Institute of Atomic Energy; Institute of Chemistry, AS; Peiping Iron and Steel Research Institute; Peiping Scientific Research Institute for Non-ferrous Metals; Power Laboratory of the AS.
SHANGHAI (31°14′N., 121°28′E.)—Chemical Industry Design Institute; Institute of Metallurgy and Ceramics, AS; Institute of Organic Chemistry, AS; Shanghai Research Institute of Pharmaceutical Chemistry.

LOCATION—SIGNIFICANCE
METEOROLOGY
CANTON (23°07′N., 113°15′E.)—Hydroelectric Power Plant.
CHENG-CHOU (34°45′N., 113°40′E.)—Silt Research Laboratory.
MUKDEN (41°48′N., 123°27′E.)—Hydraulic Research Laboratory.
NANKING (32°03′N., 118°47′E.)—Hydraulic Research Laboratory.
PANG-FOU (32°57′N., 117°21′E.)—Hydraulic Research Laboratory.
PEIPING (39°56′N., 116°24′E.)—Central Institute of Meteorological Research; Hydroelectric Power Research Institute; Institute of Geophysics and Meteorology, AS; Institute of Hydraulic Research; Laboratory of Hydraulic Engineering, AS.
SHANGHAI (31°14′N., 121°28′E.)—Hydroelectric power plant.
TIENTSIN (39°08′N., 117°12′E.)—Hydraulic research laboratory.
WU-HAN (30°34′N., 114°13′E.)—Hydraulic research laboratory.
WU-KUNG (34°17′N., 108°03′E.)—Hydraulic research laboratory.

FIGURE 76-3 (*Continued*)

LOCATION—SIGNIFICANCE

OCEANOGRAPHY

AMOY (24°30′N., 118°07′E.)—Fukien Institute of Oceanography.

CANTON (23°07′N., 113°15′E.)—Research Institute of the Ministry of Marine Products.

SHANGHAI (31°14′N., 121°28′E.)—Research Institute of the Ministry of Marine Products.

TSINGTAO (36°04′N., 120°19′E.)—Institute of Aquatic Products of the Yellow Sea; Institute of Oceanography.

TERRESTRIAL GEOPHYSICS

CANTON (23°07′N., 113°15′E.)—Geomagnetic observatory.

CH'ANG-CH'UN (43°52′N., 125°21′E.) Geomagnetic observatory.

HARBIN (45°45′N., 126°39′E.)—Branch of the (State) Bureau of Surveying and Cartography.

LAN-CHOU (36°03′N., 103°41′E.)—Geomagnetic observatory.

LHASA (29°39′N., 91°06′E.)—Geomagnetic observatory.

PEIPING (39°56′N., 116°24′E.)—Bureau of Surveying and Cartography of the General Staff; Bureau of Surveying and Cartography of the Ministry of Geology; Geomagnetic observatory; Institute of Civil and Architectural Engineering (probably at Peiping), AS; Institute of Geophysics and Meteorology, AS; (State) Bureau of Surveying and Cartography.

SIAN (34°16′N., 108°54′E.)—Branch office of the (State) Bureau of Surveying and Cartography.

TSINGTAO (36°04′N., 120°19′E.)—Geomagnetic observatory.

WU-CH'ANG (30°32′N., 114°18′E.)—Institute of Geodesy and Cartography, AS.

WU-HAN (30°34′N., 114°13′E.)—Geomagnetic observatory.

PHYSICS

CH'AN-CH'UN (43°52′N., 125°21′E.)—Institute of Optics and Precision Apparatus and Instruments, AS.

HANKOW (30°35′N., 114°16′E.)—Wu-han Geophysical Observatory, AS.

PEIPING (39°56′N., 116°24′E.)—Institute of Automation and Remote Control; Institute of Computation Techniques, AS; Institute of Mechanics; Institute of Physics, AS; Institute of Semiconductors, AS; Laboratory of Theoretical Physics, IAE, of the AS; Peiping Glass Factory; Talai Works.

SHANGHAI (31°14′N., 121°28′E.)—Institute of Radio Techniques; Shanghai Camera Plant; Shanghai Scientific and Industrial Instrument Research Institute.

SWATOW (23°22′N., 116°40′E.)—Swatow Photographic and Chemical Plant.

MATHEMATICS

PEIPING (39°56′N., 116°24′E.)—Institute of Mathematics, AS.

SHANGHAI (31°14′N., 121°28′E.)—Branch of the Institute of Mathematics, AS.

ASTRONOMY

CANTON (23°07′N., 113°15′E.)—Radioastronomical facility.

HANKOW (30°35′N., 114°16′E.)—Wu-han Geophysical Observatory, AS.

K'UN-MING (25°04′N., 102°41′E.)—K'un-ming Astronomical Observatory.

LO-HSUEH (26°16′N., 102°52′E.)—Lo-hsueh High Mountain Laboratory (Mt. Lo-hsueh Cosmic Ray Observatory).

NANKING (32°03′N., 118°47′E.)—Purple Mountain Observatory; Radioastronomical facility.

PEIPING (39°56′N., 116°24′E.)—Peiping Astronomical Observatory; Peiping Planetarium; Peiping Radio-Astronomical Observatory.

SHANGHAI (31°14′N., 121°28′E.)—Zikawei Observatory; Zo Se Observatory.

TIENTSIN (39°08′N., 117°12′E.)—Branch of the Purple Mountain Observatory; Tientsin Latitude Station.

TSINGTAO (36°04′N., 120°19′E.)—Branch of the Purple Mountain Observatory.

WU-HAN (30°34′N., 114°13′E.)—Radioastronomical facility.

LOCATION—SIGNIFICANCE

MEDICAL AND VETERINARY SCIENCES

CH'ANG-CH'UN (43°52′N., 125°21′E.)—Institute of Applied Chemistry.

DAIREN (38°55′N., 121°39′E.)—Dairen Institute of Biologicals.

HARBIN (45°45′N., 126°39′E.)—Institute of Veterinary Medicine.

LAN-CHOU (36°03′N., 103°41′E.)—Northwest Institute of Zootechnics and Veterinary Medicine.

NANKING (32°03′N., 118°47′E.)—East China Agricultural Research Institute.

PAI-CHIA (48°13′N., 126°39′E.)—Pai-chia Special Disease Research Institute.

PAO-SHAN (25°07′N., 99°09′E.)—Foot-and-mouth disease biological production station.

PEIPING (39°56′N., 116°24′E.)—Central Institute of Biologicals; Institute of Biophysics; Institute of Botany; Institute of Entomology; Institute of Epidemiology and Microbiology; Institute of Experimental Medicine; Institute of Labor Hygiene, Labor Protection, and Occupational Diseases; Institute of Microbiology; Institute of Oncology; Institute of Psychology; Laboratory of Bacteriology; Laboratory of Zoology; North China Agricultural Research Institute; Peiping Tumor Hospital; Research Institute of Chinese Traditional Medicine.

SHANGHAI (31°14′N., 121°28′E.)—Academy of Military Medical Sciences of the CPLA; Institute of Biochemistry; Institute of Experimental Biology; Institute of Materia Medica; Institute of Physiology.

TIENTSIN (39°08′N., 117°12′E.)—Institute of Blood Transfusion and Hemopathology; Institute of Labor Hygiene, Labor Protection, and Occupational Diseases (Tientsin Branch).

WU-HAN (30°34′N., 114°13′E.)—Laboratory of Bacteriology.

EDUCATIONAL INSTITUTIONS

AMOY (24°30′N., 118°07′E.)—Amoy University.

CH'ANG-CH'UN (43°52′N., 125°21′E.)—Kirin University, Department of Physics of Metals and Crystallography.

DAIREN (38°55′N., 121°39′E.)—Dairen Engineering College.

HARBIN (45°45′N., 126°39′E.)—Harbin (Polytechnical) Engineering College.

LAN-CHOU (36°03′N., 103°41′E.)—Lan-chou University, Department of Chemistry.

MUKDEN (41°48′N., 123°27′E.)—Northeast (Polytechnical) Engineering College.

NANKING (32°03′N., 118°47′E.)—Nanking Engineering College; Nanking University, Departments of Chemistry, Meteorology and Climatology.

PEIPING (39°56′N., 116°24′E.)—China Union Medical College; Peiping Medical College; Peiping University, Departments of Physical Chemistry, Geophysics (Meteorological Division), and Mathematics.

SHANGHAI (31°14′N., 121°28′E.)—Fu Tan University, Departments of Chemistry, and Mathematics and Mechanics.

TIENTSIN (39°08′N., 117°12′E.)—Nankai University, Department of Chemistry.

TSINGTAO (36°04′N., 120°19′E.)—Shantung College of Oceanography.

WU-CH'ANG (30°32′N., 114°18′E.)—Wu-han University.

Institute of Organic Chemistry (Yu-chi Hua-hsueh Yen-chiu-so), Shanghai—Director: Dr. Chuang Ch'ang-kung, since 1950. Deputy director: Dr. Wang Yu since 1954. Subordinate to the Academy of Sciences, this institute was acquired from the old *Academia Sinica* in 1950; operations began in 1953. Early research here was on antibiotics, vitamins, and drug synthesis from natural products. By 1958 this facility had increased its staff to about 200, including 13 senior research chemists. There are six laboratories, concerned with carbohydrates, polypeptides, alkaloids, steroids, polycyclic compounds, polysaccharides, and microbiology. Current research includes continued work on antibiotics, vitamins and drugs; studies on multiple uses for agricultural products, such as in plastics and synthetic fibers; high molecular compounds; and organic chemical analysis. Accomplishments have been in the applied field toward the successful production of known antibiotics and drugs. This is probably the most active organic research facility in Communist China.

Institute of Petroleum (Shih-yu Yen-chiu-so), Dairen—Director: Yang Wei, since 1957. This institute is an outgrowth of the former South Manchuria Railways Central Experiment Station, operated by the Japanese prior to the end of World War II. From 1945–49, it was under Soviet control and known as the China Ch'ang-ch'un Railway Company Scientific Research Laboratory. From 1949–51, it was called the Dairen University Annex Research Laboratory and still employed a few Japanese technicians. The name was again changed in 1952 to the China Science Institute Industrial Chemistry Research Laboratory and, finally, to its present name in 1953. Subordination has been to the Academy of Sciences since about 1953. Inactive to the end of the Soviet Occupation, the laboratory then began applied research on oil shale and on petroleum analyses. Achievements have been claimed in the production of jet fuel from shale oil and the construction of a 2-Mev. cyclotron. Current research is underway on petroleum refining by catalytic processes, new catalysts, synthetic fuel production, and petroleum analysis by gas chromatography.

Kirin University (Chi-lin Ta-hsueh), Ch'ang-ch'un—Director: Lu Chen-yu. Formerly, Northeast People's University. Subordinate to the Ministry of Education, the university has one department of interest here, that for the Physics of Metals and Crystallography, which gives advanced training in the field and has published creditable research.

Lan-chou University (Lan-chou Ta-hsueh), Lan-chou—Director: Lu Yun-ju. This university, subordinate to the Ministry of Education, was founded in 1946. While specializing in geology and geophysics, there is increased activity in chemical research. Current work includes applied research on petroleum ash analysis by polarography, organic analysis, and synthesis of heterocyclic compounds.

Nankai University (Nan-k'ai Ta-hsueh), Tientsin—President: Yang Shih-Hsien, since 1956. Subordinate to the Ministry of Education. Current research of the university's chemistry department concerns insecticides, ion exchange resins, and organoarsenic compounds.

Nanking University (Nan-ching Ta-hsueh), Nanking—Director: P'an Shu since 1954 or possibly Kuo Ying-chiu since 1958. Deputy director: Fan Tsung-chung since 1958. Subordinate to the Ministry of Education, this facility was reorganized in 1952 when Chung Yang and Ginling universities were combined. There are thirteen departments, including a chemistry department. Current research is on organic synthesis, preparation of ion exchange resins, spectroscopy, polarography. This university is scheduled to become the center of Communist Chinese microwave research in cooperation with other universities. Laboratory equipment for undergraduates is considered to be better than that at similar Japanese educational institutes, but research facilities for the teaching staff are lacking.

National Rubber Industrial Research Center, Tientsin—This center was established in 1954 and operates under the jurisdiction of the Rubber Industry Corporation of the Ministry of Chemical Industry. The center has about 500 workers. It has a pilot plant for making experimental tires and is equipped with calenders and modern rubber test equipment obtained from the U.S.S.R., East Germany, Czechoslovakia, and Japan. The center's library contains about 70% rubber literature which is of Soviet origin. Soviet synthetic rubber specialists were observed in the center in 1957.

Peiping Iron and Steel Research Institute (Pei-ching Kang-t'ieh Yen-chiu-so), Peiping—Director: Lu Ta since 1958. Variant: Peiping Institute of Ferrous Metallurgy. Founded in 1952, it is subordinate to the Ministry of Metallurgical Industry. It is probably the best equipped facility of its kind in Communist China.

Shanghai Chemical Industry Research Center, Shanghai—This center is located within "Tien Yuan" Chemical Plant, Shanghai, which is a joint state and privately operated corporation. Established in 1956, it is under the jurisdiction of the

Shanghai State Chemical Research Institute of the Ministry of Chemical Industry. It has succeeded in producing, on an experimental basis, a superphosphate fertilizer requiring no sulfuric acid. Research is conducted on chemical fertilizers and machinery; superphosphate, sulfuric acid, nitric acid, ammonia, nitrogen and oxygen are produced. The staff includes approximately 180 persons. Scientists and engineers participated in the All-Chinese conference on "industrial energy, heat transfer, and mass transfer" in Nanking in July 1959, under the sponsorship of the Nanking Engineering College and the Power Laboratory of the AS.

Shenyang National Chemical Research Institute, Mukden—Director: unknown. Subordinate to the Ministry of Chemical Industry, and may be known as the Institute of Chemical Technology. Established about 1948, this institute uses buildings formerly occupied by the Nanman Sugar Refinery, and adjoining the Shenyang Dye Plant constructed about the same time. Research was conducted on dye synthesis in 1953. By 1958 the institute claimed experimental production of several new dye intermediates.

d. OUTSTANDING PERSONALITIES

CHOU Jen (0719/0088),* Dr.—Metallurgy, specializing in the manufacture of graphite, cast iron, and porcelain. Director, Institute of Metallurgy and Ceramics, AS, Shanghai. Member, Standing Committeee of the Department of Technical Sciences, AS, since 1955. Chairman, Metallist Society of the China Federation of Scientific Societies. Delegate to the National People's Congress from Shantung Province in 1954. From 1931–49, Chou was active in various scientific and political organizations in Yünnan province. During that same period, he was employed as chief engineer and general manager of the China Electric Steel Company in K'unming, Yünnan province. Chou has published several articles on metallurgy, including two entitled "Properties of Certain Low Alloy Steels" and "Scientific Research on Chinese Ceramics." Described as the first metallurgist to do research in electric furnace smelting, Chou recently succeeded in manufacturing a graphite cast iron, an inexpensive metal substitute for steel which is now being used in the construction of railways and bridges in China. In 1956, he announced that his institute had produced eggshell porcelain as thin, smooth, and lustrous as the famous porcelain of the K'ang Hsi period. He has been variously described as "an outstanding Chinese engineer" and "primarily an administrator of science." Born: 1892.

FU Ying, Prof. Dr.—Physical chemistry, surface chemistry and catalysis. Professor of colloid chemistry, Peiping University and member, Scientific Committee, Institute of Applied Chemistry, Academy of Sciences, since 1956. Head, Department of Chemical Engineering, Peiping University, 1953. Professor of chemistry, Chungking University, and concurrently director of research, Tung Li Oil Works, from 1944–45. Awarded, first prize of the Chinese National Defense Commission for "Synthesis of High Vacuum Pump Oils for Diffusion Oil Pumps from Chinese Raw Materials," 1945. Recent research: studying poisoning and depoisoning of catalysts. Born: 1903.

HOU Te-pang, Dr.—Chemical engineering and industrial chemistry. World authority on production of soda ash and foremost Chinese industrial chemist and chemical engineer. Deputy minister of the Ministry of Chemical Industry, 1958; director, Yung Li Chemical Industry, Nanking, 1934–53; chief engineer, Wah Chang Co., New York, 1941–45. Member, Academic Council, Academy of Sciences, 1952; chairman, Chinese Society of Chemistry, 1954. Has received various honors. Visited Japan as head of Chinese Communist Chemical Industry Inspection Party, 1958; England, 1943; United States, 1917–21, 1941–45. Currently, he is attempting to acquire technical data from Western countries. Born: 8 August 1890.

HUANG Tzu-ch'ing, Prof. Dr.—Physical chemistry, thermodynamics and electrochemistry. Professor of physical chemistry, Chemistry Department of Peiping University, since 1958. Chief, Research Office for Physics and Chemistry of Peiping University. Member, standing committee of the board of directors of the Chinese Chemical Society, 1953. Recent research on electrolytic deposition studies and battery development work. Born: 1900.

KO T'ing-sui (5514/1656/3606), Prof. Dr.—Metal physics, specializing in spectroscopy and the deformation of metals. Has done outstanding research on the development of materials for use at high temperatures, such as are needed for aircraft and rocket parts. Noted especially, also, for his work on the atomic bomb and radar during the World War II period for the U.S. Government. Deputy director, Institute of Metals, Mukden, since about 1954. Member, Standing Committee, Department of Mathematics, Physics, and Chemistry, AS, since 1955. Educated, taught, and worked, variously, in the United States at the University of Chicago, University of California at Berkeley, MIT, Princeton, and Johns Hopkins universities, and others. Until April 1945, he was a staff member of the Spectroscopy Laboratory of the Division of Industrial Cooperation (Manhattan Project), working on the development of special methods, procedures, and techniques for spectroscopic analysis, in both emission and absorption spectra. Ko, subsequently, did work for the Office of Naval Research and other work for the U.S. Government. He returned to China in 1949, and has taught at various Chinese universities. Is a member of several professional societies, including the American Physical Society, the Optical Society of America, and the American Institute of Mining and Metallurgical Engineers. Was awarded the Chinese Academy of Sciences' prize in January 1957. Member of editorial committee of physics journal, and has published numerous scientific articles. The titles of several recent articles include: "Creep of Polycrystalline Iron under Small Torsional Stress and the Effect of Carbon upon the Creep," and "Diffusion and Precipitation of Carbon

* Standard Telegraphic Code (STC) numbers, numerical representations of Chinese characters, are given for the names of those individuals for whom Chinese characters are available.

and Nitrogen from Solid Solution in Iron and Steel." Speaks English and has a reading knowledge of German and French. Born: 1913.

LI Hsün (2621/5651), Dr.—Ferrous metallurgy and research administration. Director, Institute of Metals, AS, Mukden, since 1954. Member, standing committee of the Department of Technical Sciences, AS, since 1955. Formerly, reader in the Department of Metallurgy, Sheffield University, United Kingdom, until late 1951 or early 1952, when he returned to China. Li's first project at the Institute of Metals concerned nodular cast iron and, in 1956, he was working on nodular problems in steel. Li, in collaboration with other staff members at the institute, is known to have produced two technical papers since his return to Communist China: "An Investigation on the Effect of Manganese Specification in Basic Open Hearth Process," and "The Distribution of Hydrogen in Annealed Steel Ingots." Served as a delegate to the Moscow Conference on the Chinese Twelve Year Plan, 1958. Date of birth: unknown.

LIU Ta-kang, Prof. Dr.—Inorganic chemistry. Deputy director, Institute of Chemistry, Peiping, and heads the inorganic chemistry section of the same institute. Has served recently as technical expert to the China Democratic League and the Ministry of Education as a replacement for Chao-lun Tseng, who was demoted in 1958 for political unreliability. Was formerly associated with the Institute of Applied Chemistry in 1957 and was a member of the Secretariat of the Chinese Academy of Sciences in 1954. Attended the Eighth Mendeleyev Congress on General and Applied Chemistry, Moscow, in 1959. Educated in the United States at the University of Rochester. Has knowledge of both German and English languages. A leader of Chinese research on rare elements, including separation of the rare earths. Date of birth: unknown.

PENG Shao-i, Dr.—Organic chemistry. Director of the Institute of Petroleum, Dairen, 1954–57. Present position unknown. Author of papers on petroleum and shale oil chemistry. Received a Third Class Science Award from the AS in 1957 for his research in collaboration with others on synthetic fuel production. Visited the United States in 1947. Member of Chinese delegation to the U.S.S.R. to study Soviet research methods in 1953. Born: 1917.

SHIH Ju-wei (2457/3067/3634), Prof. Dr.—Crystallography, crystal structure of metals and alloys, semiconductors. Director, Institute of Applied Physics (now the Institute of Physics), AS, since 1955 and affiliated with that same institute since 1951. Member, Department of Physics, Mathematics, and Chemistry, AS. Professor of Physics, Tsinghua University, 1925–40. Member, Second National Committee of Chinese People's Political Consultative Conference, since 1954. Represented the All-China Federation of Scientific Societies at the Vienna Conference of the World Federation of Scientific Workers, 1954. Member, Peiping branch of the Chinese Physical Society in 1954 and, in 1956, was elected a member of the presidium of the Second National Committee of the China Educational Workers' Trade Union. Research has concerned the magnetic properties of alloys and compounds and has been the author of "Weakness Coefficient of Alloys" and "The Effect of Elastic Stress in Coercive Forces Is Extended to Different Crystallographic Directions of Both Iron and Nickel-type Structure." Born: 1902.

WANG Yu (3076/3731), Dr.—Biochemistry, specializing in antibiotics research; known especially for his rediscovery in 1945 of citrinin (*Penicillium citrinum*), a derivative of a mold similar to that which produces penicillin. Deputy director, Institute of Organic Chemistry, AS, Shanghai, since 1954. Member, Department of Physics, Mathematics and Chemistry, AS, since 1955. Member, 12-man National Antibiotic Research Committee since its establishment in 1955 (deputy director, 1956). Director, Antibiotic Research Committee of Shanghai, 1956. Member, Chinese National Committee for Biochemistry, and head of Chinese delegation which attended the Third International Congress of Biochemistry held in Brussels, 1955. Has been a Second National Committee member at the Chinese People's Political Consultative Conference since 1956. Formerly, did research at the Institute of Medicine and Pharmaceutical Research, 1945–48, and worked at the Pincomb Chemical Works, Shanghai, in 1942. Studied in China, but did graduate work at the University of Munich. In 1954–56, affiliated with the Institute of Organic Chemistry (deputy director in 1954 and member of academic committee in 1955–56). Awarded Third Class Prize of 2,000 yuan by the AS in 1957 for his research on antibiotics. Early work was on sterol, but his most important research, that on citrinin, occurred during the 1940's. Subsequent work has been on the stereochemistry of citrinin and on the development and production of aureomycin. Wang is the author of many scientific articles, including: "Paper Chromatography of Aureomycin" (1955) and "Research into the Chemistry of Antibiotics from Tangerine." Born: 1917.

YANG Shih-hsien (Yuan Si shen), Dr.—Organic chemistry, specializing in organophosphorous research. One of the best organic chemists in Communist China. At Nankai University (president, since 1956; vice president, 1953–56). Member, Standing Committee of the Department of Physics, Mathematics and Chemistry of the AS since 1955. Member, Chinese delegation to U.S.S.R. which obtained advice from Soviet scientists on the Twelve Year Plan. Chairman, board of directors of the China Society of Chemistry in 1956. Member of the Scientific Committee of the Institute of Applied Chemistry in 1956. Attended the signing of the Sino-Soviet Scientific Cooperation Agreement in 1959 and attended the Eighth Mendaleyev Congress in Moscow the same year. Studied in the United States and did his graduate work at Yale. His most recent research has been on the synthesis of plant growth regulators. Born: 1898.

2. Meteorology and hydrology

a. GENERAL

(1) *Capabilities and trends* — Communist Chinese capabilities in meteorology and hydrology are rather low when compared with leading nations of the West and with the U.S.S.R.; however, in the eleven years which have elapsed since the Communists took control of the government, progress in these fields has been fairly rapid. The meteorological research effort during these eleven years has been to increase forecasting capabilities and to expand both the meteorological and hydrological observational network, in order to provide adequate support to the military forces, especially during the Korean War, and to agriculture, civil

aviation, and various industries. Support to the civilian components also has been stressed. In hydrology, Communist China's aims are to control the disastrous floods and, at the same time, to harness the tremendous water resources to the greatest advantage of irrigation, navigation, and the generation of power.

Meteorological research during the early years of the Communist regime was concentrated primarily in: 1) synoptic meteorology, to understand the peculiar behavior of atmospheric phenomena which arise because of topographical or other local conditions; and 2) climatology, to establish mean or median weather conditions over the country. Currently, the greatest emphasis is on dynamic and physical meteorological research.

In hydrology, much of the Communist Chinese attention has been concentrated on the collection of stream-gaging data, on the reduction of the heavy silt of the Yellow River (*Huang Ho*), as well as on the omnipresent problems of soil improvement, drainage, irrigation, canal building, improvement of river banks, and the construction of levees.

Despite some progress, the most critical Communist Chinese weakness in the fields of meteorology and hydrology is the shortage of adequately trained personnel with which to carry out an operational program, to conduct research, and to train new scientists.

Another Communist Chinese weakness is a shortage of instruments. This shortage is not so apparent in the routine observational instruments, but, for some research fields such as cloud physics which require special and complex instruments, the requirements have not been met. The Communists acquired almost all of the instruments which had been used by the Nationalist Chinese weather service, but by now those which are still in service are rapidly becoming obsolete. FIGURE 76–4 shows weather and meteorological instruments in use in Communist China. Communist China has been able to purchase some instruments from the U.S.S.R. and from other Soviet bloc countries, as well as from certain Western countries, and they have begun to manufacture some of the instruments internally. Thus, the instrument shortage has begun to be eased, but it will be several years before internal production can entirely serve the needs of the two sciences.

Because of political considerations, Communist China has not become a member of the most important international organizations for meteorology and hydrology; however, Communist Chinese observers have attended some international meetings, and the country actively participates in Sino-Soviet bloc meteorological and hydrological activities.

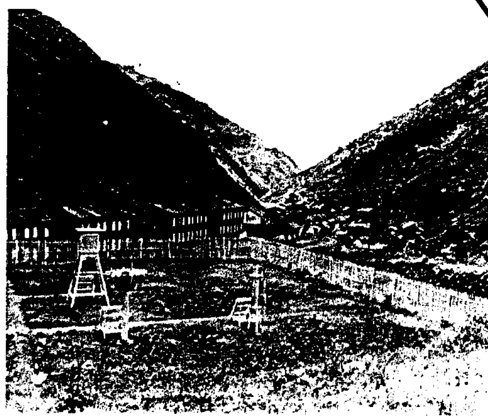

FIGURE 76–4. STANDARD WEATHER INSTRUMENTS AT COSMIC RAY OBSERVATORY ON LO-HSUEH MOUNTAIN, NEAR K'UN-MING, 1957

(2) *Background and organization* — Meteorology and hydrology were studied very early in China. The history of hydrology and hydraulics dates back over 4,000 years. Wind vanes were used and weather was recorded as long as 2,200 years ago. The first section of China's Grand Canal was begun in the 7th century A.D. and since its completion in the 13th century it has remained the longest canal in the world. In many respects, Chinese knowledge of meteorology exceeded that of Western Europe up to the 15th century.

Up to about 1912, when the republic was established, almost all significant meteorological and hydrological activities in China were conducted by foreign powers. Shortly thereafter, the Central Meteorological Observatory was established in Peiping, and the basic foundations were laid for meteorological and hydrological research. This facility is now known as the Central Institute of Meteorological Research (*Chung-yang Ch'i-hsiang Yen-chiu-so*). The Meteorological Society of China (*Chung-kuo Ch'i-hsiang Hsueh-hui*) was founded in 1924, and four years later the National Academy of Sciences (*Academia Sinica*), together with its Institute of Geophysics and Meteorology (*Ti-ch'iu Wu-li Yen-chiu-so*), Peiping, was formed. Despite these measures, progress in the two sciences remained at a low level, and was disrupted entirely when the Japanese invaded the country in 1937. Meteorological and hydrological work was begun again following World War II under U.S. technical guidance and assistance; however, activity in the two fields remained at a low level when the Communists gained control in 1949.

The Communist regime in China placed the operational weather service under military control when it created the Meteorological Bureau of the Military Council late in 1949. The Military Council built some observatories and stations in regions where meteorological services were most urgently needed to support the national defense, and they also attempted to improve the meteorological communications. The council established short-term training courses for observer personnel and, together with the Institute of Geophysics and Meteorology under the Chinese Academy of Sciences, Peiping, established a joint Weather Analysis Report Center and a department for data processing under the Central Institute of Meteorological Research. Some research was conducted during this period mainly by the Institute of Geophysics and Meteorology of the Academy of Sciences, but most of the effort was diverted toward strengthening the observational network and providing an adequate forecasting service for the military services. FIGURE 76–5 is a map which shows the location of known radiosonde and pilot balloon stations in Communist China.

The Communist Chinese Academy of Sciences is the foremost organization concerned with the overall planning, control and conduct of meteorological and hydrological research. While the (State) Scientific and Technological Commission (*K'o-hsueh Chi-shu Wei-yuan-hui*) determines the research program to be adopted, the research institutes of the academy and other organizations actively engaged in research undoubtedly initially prepare the program. The Institute of Geo-

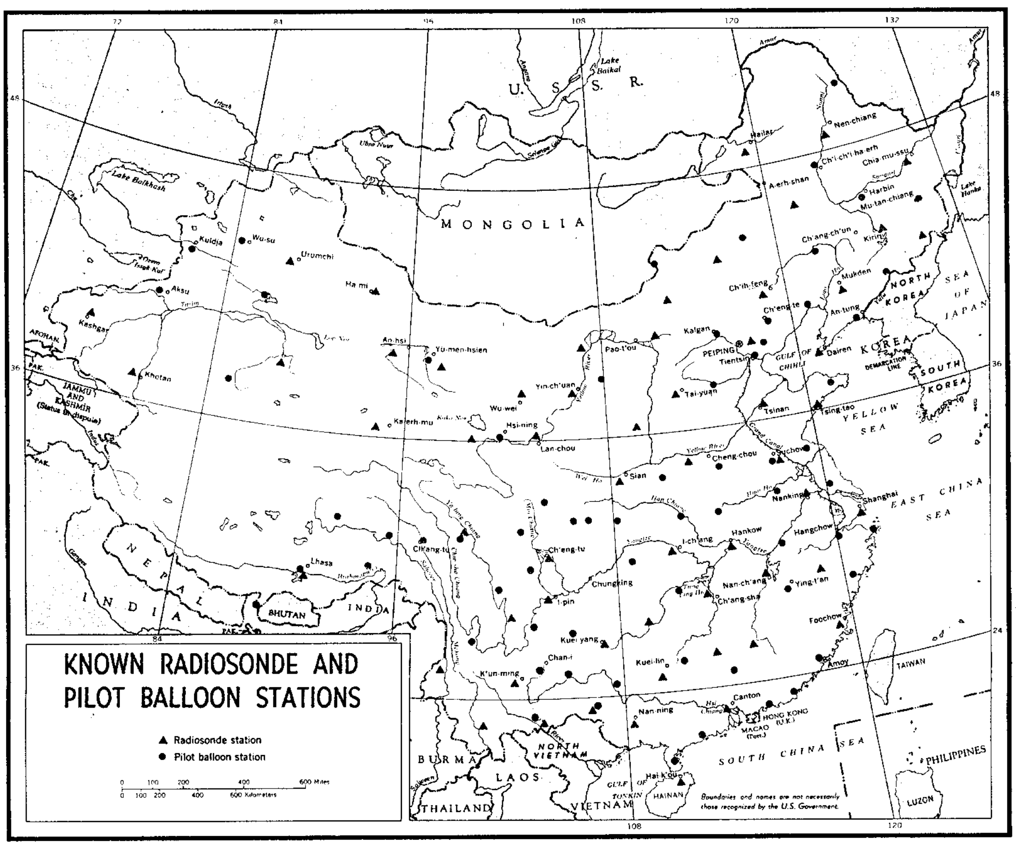

FIGURE 76–5. KNOWN RADIOSONDE AND PILOT BALLOON STATIONS, COMMUNIST CHINA, 1958

physics and Meteorology, under the Department of Earth Sciences, is the most active institute engaged in meteorological research. For hydrological research, the Department of Geography with its Hydrologic Institute, and the Department of Technical Sciences with its Laboratory of Hydraulic Engineering (*Shui-kung Yen-chiu-shih*), Peiping, are the most important. Branches of the Academy of Sciences, with associated research institutes, were established in many provinces during 1958, and a few of these branches have begun research in meteorology and hydrology. However, these branches are generally understaffed and have poor facilities, and their research programs are presently only of minor importance.

The (State) Scientific and Technical Commission of the State Council plays a dominant role in controlling and planning meteorological and hydrological research in Communist China. It controls the expenditures and passes on the budgets of institutes, compiles annual research plans, coordinates all research, assigns responsibilities for joint scientific expeditions, and has the authority to merge institutions. The commission has both civilian and military representation and, therefore, probably controls and coordinates military as well as civilian meteorological and hydrological research programs.

Following the Korean armistice in 1953, the Central Meteorological Bureau (*Chung-yang Ch'i-hsiang Chu*) was established under the State Council. The bureau provides operational meteorological support to all phases of the nation's economy, except the military services, which maintain their own forecasting services. It controls the observational network and provides weather forecasts for all civilian activities. Through its observational network, it provides much of the basic weather information for the military weather service. The duties of the Central Meteorological Bureau are primarily operational, but some research has been conducted, primarily by the Central Institute of Meteorological Research. A very limited amount of meteorological research also has been conducted at some of the provincial observatories of the Central Meteorological Bureau. Since almost all meteorological research has as its goal the improvement of weather forecasting, the Central Meteorological Bureau, as the prime Communist Chinese forecasting organization, probably has a great deal of influence in the formulation of the meteorological research program. Figure 76–6 shows the subordination of the leading Communist Chinese meteorological organizations and institutes.

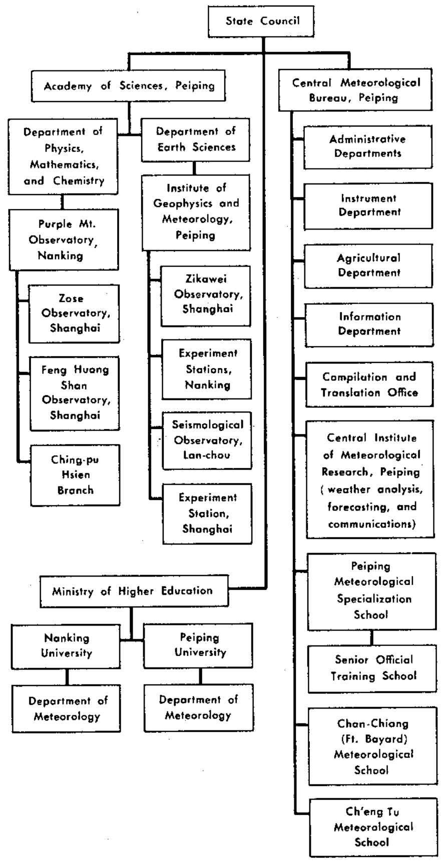

Figure 76–6. Leading Communist Chinese civilian meteorological organizations and institutes

The Meteorological Bureau of the Military Council is the weather forecasting unit for the military services; its duties are primarily operational. However, the Meteorological Bureau participated with the Central Meteorological Bureau and the Academy of Sciences in 1958–59 weather control experiments, and it is likely that it conducts other meteorological research which has direct bearing on military activities. Like the Central Meteorological Bureau, the Meteorological Bureau of the Military Council probably has considerable influence on the research program.

The Ministry of Water Conservancy and Electric Power (*Shu-li Tien-li Pu*) executes the water conservancy program of the country. Some research is done in the ministry's departments for design, engineering, and hydrology. Major research and model testing is conducted in the ministry's hydraulic and hydroelectric power research institutes in Peiping and in its other hydraulic research laboratories at Nanking, Tientsin, Mukden, and Wu-kung. The institute in Peiping is the main facility in this field in Communist China. It is believed that the Silt Research Laboratory in Cheng-hsien and the hydraulic research laboratories at Wu-han and Pang-fou are directly subordinate to the ministry, although they may be under the control of the ministry's river conservancy commissions. The ministry probably exercises some control over the other hydroelectric power research institutes, such as those of Canton and Shanghai; these institutes are instrumental in designing hydroelectric powerplants and cooperate closely with the hydraulic research facilities responsible for the design of dams and reservoirs. The activities of the ministry's Institute of Hydraulic Research (*Shui-li K'o-hsueh Yen-chiu-yuan*), Peiping, and laboratories appear to be closely coordinated with those of the academy. The ministry's research on soil conservation and improvement is done in conjunction with the program of the Ministry of Agriculture (*Nung-yeh Pu*); regional and river surveys, including hydrogeological research, are usually carried out together with projects of the Ministry of Geology (*Ti-chih Pu*).

Peiping and Nanking Universities are the principal training centers for meteorology in Communist China. Together with their training responsibilities, they have begun to conduct a small amount of research. Some hydrologic and hydraulic research is conducted by the technical universities and water conservancy colleges; however, the universities probably do not play a major role in the planning or control of meteorological and hydrological research.

The Meteorological Society of China (*Chung-kuo Ch'i-hsiang Hsueh-hui*) and the Water Conservancy Society of China (*Chung-kuo Shui-li Hsueh-hui*) are the two major professional societies which influence meteorological and hydrological research in Communist China.

b. MAJOR RESEARCH AND DEVELOPMENT BY FIELD

(1) *Meteorology*

(a) SYNOPTIC METEOROLOGY — Synoptic research is generally of a descriptive nature in which detailed studies of the variable atmospheric parameters (pressure, temperature, humidity, and wind) are made in connection with a particular storm, cold wave, drought, flood, or other weather phenomena. Synoptic studies, in addition to describing the state and change of the atmospheric variables, usually attempt to determine the most important changes which appear to give some indication of the future development of the particular weather phenomenon being studied. In this manner, forecasting rules or guides are developed for future use when similar phenomena occur. Synoptic research also provides a more complete understanding of atmospheric processes, and forms the basis for a quantitative or mathematical description of atmospheric processes. (See FIGURE 76–7 for the locations of known synoptic weather stations in Communist China.)

Typhoons constitute a major threat to the coastal regions of Communist China, especially during the autumn months. Consequently, considerable emphasis has been given to the study of these storms with the goal of improving typhoon forecasts. Research has included description of typhoon tracks and formulation of statistical aids in forecasting their movements. Research has also been conducted on the three dimensional structure of typhoons, relationship between typhoon movement and the general circulation, and favorable atmospheric conditions for typhoon formation. An objective method which utilizes spatially averaged winds as an indication of the direction and speed of the typhoon motion has been described for predicting typhoon movement. This method uses an average of the wind in a circular area of 400 kilometers (about 250 miles) in diameter, centered at the typhoon and extending from the earth's surface to the constant pressure-surface of 300 millibars (approximately 30,000 feet in height). It is believed that the speed of the typhoon will be proportional to the speed of the calculated average wind, and the direction of movement will be conicident with the direction of the average wind. This method is similar to one developed and used with some success for forecasting hurricane movement in the United States. Although Communist Chinese synoptic research applicable to typhoon forecasting in general has been competent, it has not been equal in quality or in quantity to that conducted by the Japanese who have a similar forecasting problem with typhoons.

Synoptic research applicable to long-period weather forecasting has received more emphasis than any other type in Communist China. Until 1953, this research concentrated on using statistical techniques based upon climatological data for compiling long-period weather forecasts. This type of research often degenerated into correla-

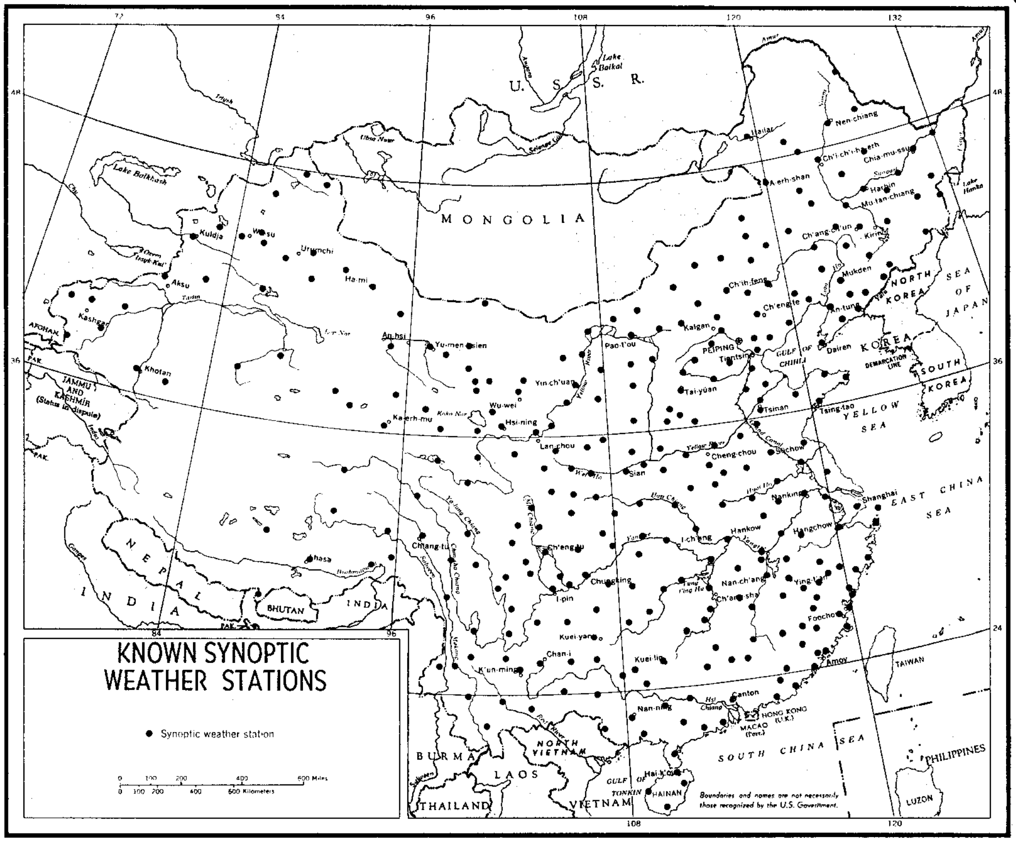

Figure 76–7. Known synoptic weather stations, Communist China

tion techniques which had no physical basis. Since 1953, Communist Chinese synoptic research applicable to long-period forecasting has followed the Soviet Multanovskiy technique, and they have used this method to produce operational long-period forecasts. Most of the Communist Chinese studies following the Multanovskiy approach have not been novel but merely have repeated similar Soviet research. The Soviets have shown a trend away from the Multanovskiy approach, and it is likely that the Communist Chinese will follow. Another synoptic approach, developed in the United States and involving the use of average upper air maps and circulation indices, also has been studied to a limited degree by the Communist Chinese. They claim to have used this method to produce seasonal weather forecasts; however, a 30-day forecast based upon this method shows only a small skill score, and a seasonal forecast would have even less reliability.

Some of the most competent Communist Chinese synoptic research has been a series of studies on the general atmospheric circulation. Research on the general circulation has, as its goal, the improvement of both short-period and long-period forecasts. This research is very important for civil and military aviation since it describes the atmospheric motion at the altitudes normally used by modern aircraft. Communist Chinese research on the general circulation has followed three main approaches: 1) to describe the structure of the atmospheric circulation and its seasonal change; 2) to determine the controlling factors of the circulation over East Asia; and 3) to determine the main weather systems in East Asia.

The Communist Chinese have found that, during the winter, there are usually two jet streams* over the mainland which converge into one over Japan. During the summer, the circulation was found to be much more complex, with a westerly jet stream between 40° and 45° north, and an easterly jet stream between 10° and 15° north. The mean 500-millibar (approximately 18,000 feet) maps compiled by the Communist Chinese have indicated the average position of the semi-permanent low pressure trough to be located farther west than the average position found by U.S. meteorologists. The main weakness thus far in the Communist Chinese research describing the structure of the general circulation has been the neglect of such work for the spring and autumn months of the year. It is during these months that the changes in the average circulation are most pronounced and thus are of considerable interest and importance. The Communist Chinese have studied the effects of the Tibetan plateau and of the heat distribution on the general circulation. Such research is very important as a background for further research on the dynamics of atmospheric circulation.

(b) DYNAMIC METEOROLOGY — Dynamic meteorology is the study of atmospheric motions, as represented by the equations of hydrodynamics or other systems of equations appropriate to special situations, as in the statistical theory of turbulence. Dynamic research gives a quantitative description of atmospheric motion, and it forms the basis for numerical weather prediction.

Numerical weather prediction (NWP) is the result of the solution of the hydrodynamical equations. The solution of these equations was not possible, except in a very simplified form and with many qualifying assumptions, until electronic digital computers became available to handle the phenomenal number of arithmetic computations involved. Even with a computer, certain assumptions must be made, and an exact solution is still not possible. Nevertheless, NWP is now the most accurate method available for predicting the atmospheric motion at levels between 10,000 and 20,000 feet.

The Communist Chinese are not known to have had a computer available to aid them in NWP research, but since 1954 they have conducted some competent research on the basic NWP theory. Studies of topographical effects on numerical forecasts have indicated that these effects are much greater over China than over North America. Preliminary research has been conducted on the effect of heat sources on atmospheric motion. This type of research is very important for long-period numerical forecasting. All of the Communist Chinese research on NWP has been restricted to a degree, because they have no computer available to test forecasting models. They have circumvented this somewhat by using graphical methods to get a qualitative idea of the model's potential.

In 1958, the Communist Chinese adopted the Soviet linear NWP method of long-period weather forecasting. The equations for this method can be solved on hand calculators, but the linearization process restricts the forecasting accuracy. After five years of experimentation with the method, the Soviets turned to a nonlinear approach because verification studies showed that the numerical forecasts were no better than those made by ordinary subjective techniques. The Communist Chinese are aware of the Soviet findings and are expected to discontinue this approach when they have access to a computer capable of solving the more complex nonlinear equations.

Dynamic research also has been conducted by the Communist Chinese on the movement of typhoons; some emphasis has been on the movement at the time of recurvature. Theoretical formulation has shown that the speed of typhoons tends to diminish before recurvature, and to increase after recurvature—a phenomenon generally supported by Western observations. A detailed analysis also has been made of the production of kinetic energy in the atmosphere, and the effective potential energy over the Northern Hemisphere has been computed. These studies are important in understanding the general atmospheric circulation.

The Communist Chinese have conducted some preliminary dynamic research on the energy distribution and exchange in the jet stream. A formula has been established describing the energy equilibrium in the jet stream which agrees in general with observations, with the exception of an upward bias for extreme instability and a small downward bias for stable conditions. Dynamic research on the energy exchange and distribution in the jet stream potentially is of great importance, particularly for long-period weather forecasting.

(c) PHYSICAL METEOROLOGY — Physical meteorology deals with the optical, electrical, and acoustical phenomena of the atmosphere, as well as with its chemical composition, the laws of radi-

* A jet stream is a relatively narrow band of high winds which drifts over the hemisphere somewhat like a river. The maximum velocity of the jet stream is usually found near the tropopause at about 30,000–40,000 feet, and wind speeds may reach as high as 300 miles per hour.

ation, and the processes which occur in clouds and precipitation. The Communist Chinese have conducted practically no physical research of significance, other than a few elementary radiation and precipitation studies.

Since 1958, weather modification by means of cloud seeding was developed as a result of cloud and precipitation physics research, and the Communist Chinese have engaged rather extensively in such experiments. The table, FIGURE 76–8, shows cloud seeding experiments as reported by the Chinese Communists. Experiments have been conducted, using techniques developed by other countries and without any statistical controls to assist them in determining the results of the experiments. They have, therefore, been unable to make any more than qualitative judgments regarding the efficiency of their experiments and, for this reason, the Communist Chinese experiments have had little scientific significance. The Chinese scientists recognize the weakness of these experiments and have pointed out the necessity of having proper statistical controls for evaluation purposes. They also have pointed out the necessity for establishing cloud and precipitation physical research in order to advance the state

FIGURE 76–8. CLOUD SEEDING EXPERIMENTS AS REPORTED BY THE CHINESE COMMUNISTS

DATE	LOCATION OF EXPERIMENT	TYPE OF EXPERIMENT	REPORTED RESULTS OF EXPERIMENT	GROUPS INVOLVED IN EXPERIMENTS
8 Aug.–12 Sept. 58.	Kirin area, parts of Yungchi, Chiao-ho and Shulan hsien.	22 experiments at cloud seeding.	70 to 80% successful	People's Liberation Army air force units supplied aircraft.
Aug.–Oct. 58.	In Ch'i-lien mountains at high altitude, Kansu province.	Inducing precipitation; melting of ice and snow; dissipation of clouds, fog, and hail (40 experiments in all).	Six experiments succeeded in producing rainfall (aircraft used).	Academy of Sciences cooperating with "departments concerned in Kansu."
Sept. 58	Lan-chou area. Chung hsien in Kansu province.	Two experiments at cloud seeding with dry ice.	Rain fell for 20 minutes following experiment on 19 Sept. 58. No report of results in other experiment except called "successful."	Institute of Geophysics and Meteorology of the Chinese Academy of Sciences; Central Meteorological Bureau; Kansu Provincial Weather Bureau; and Peiping University.
20 Oct. 58	Wu-han, Hupeh province.	Cloud seeding with dry ice.	Breaks in overcast appeared in 3 to 5 minutes and lasted for 20 minutes.	Air force unit stationed at Wu-han, Special Group of the Hupeh Provincial Weather Bureau, Department of Physics and Chemistry of the Wu-han University.
22 Oct. 58	Ch'ang-sha, Hunan province.	Cloud seeding with salt solution.	11 minutes after seeding, rainfall for 34 minutes.	
26 Nov. 58	Near Nanking, Kiangsu province.	Dissipation of stratocumulus clouds.	A few minutes after aircraft run, a "clear area" 700 meters wide and about 6,500 meters long appeared and lasted for 30 minutes.	Under the leadership of the CCP Anhwei Provincial Committee; People's Liberation Army air force; Institute of Geophysics and Meteorology of the Chinese Academy of Sciences; Anhwei Provincial Weather Bureau.
27 Nov. 58	Near Nanking, Kiangsu province.	Formation of clouds	7 minutes after seeding, a thin, long cloud zone appeared. In a few minutes, it developed into more than 1 kilometer in width and about 7 kilometers in length. Cloud lasted for about 45 minutes.	
24 Nov. 58	Tungkang in Fusung hsien, Kirin province.	Burning chemicals in ground generators to induce precipitation.	Snow fell all day in the experimental zone without affecting surrounding areas.	Central Meteorological Bureau; of Kirin and Liaoning Provinces; and People's Liberation Army units.
12 Dec. 58	Near Nanking in Anhwei province.	Fog dispersed using specially prepared "firecrackers."	Fog "successfully dispersed"—hole developed in fog in the area seeded.	Institute of Geophysics and Meteorology, and Anwhei Meteorological Bureau.

FIGURE 76-8 (*Continued*)

DATE	LOCATION OF EXPERIMENT	TYPE OF EXPERIMENT	REPORTED RESULTS OF EXPERIMENT	GROUPS INVOLVED IN EXPERIMENTS
18 Dec. 58...	Ts'ang-hsien in Hopeh province.	Artificial cloud formation.	Clouds formed at 4,000 meters and 2,500 meters above sea level. Clouds persisted 15 minutes.	Institute of Geophysics and Meteorology of Chinese Academy of Sciences; People's Liberation Army air force; and Central Meteorological Bureau.
21 Dec. 58...	Lu Shan mountains of Kiangsi province.	Cloud seeding using ground generators located "half way up the mountains."	Rain fell intermittently for nine hours.	Members of Central Meteorological and Hydrometeorological Bureaus of Kiangsi province.
23 Dec. 58...	Tientsin area, Hopeh province.	Formation of clouds.....	Clouds formed at 300 meters above sea level. Clouds were thin and persisted 6 to 7 minutes.	Institute of Geophysics and Meteorology, and Civil Aeronautical Group.
25 Dec. 58...	Canton, in Kwangtung province.	Cloud seeding from airplanes.	No report..................	No report other than one Chinese-made AN-2 aircraft participated.
26 Dec. 58...	Lu Shan mountains of Kiangsi province.	Cloud seeding using ground generators.	Rain and snow fell for 4 hours 50 minutes. Precipitation began 3 to 4 hours after seeding began.	Members of the Central Meteorological and Hydrometeorological Bureaus of Kiangsi province.
7 Jan. 59.....	Shanghai, Kiangsu province.	Seeding with silver iodide from ground generators.	Reports stated that 2 hours after the generators were started, the rainfall in the area affected by the silver iodide increased in intensity.	Artificial rain research group of the Shanghai Meteorological Center.
Jan. 59......	Liaoning province.....	Cloud seeding with dry ice to disperse clouds.	Breaks in overcast appeared 10 minutes after seeding, precipitation was accelerated and snow began to fall.	Marine unit of People's Liberation in Lu Shan-Dairen and the Meteorological Bureau of Liaoning province.
Jan. 59......	Liaoning province.....	Cloud seeding with dry ice to increase precipitation.	Heavy snowfall lasted about 4 hours.	

of the art of weather modification. The map, FIGURE 76–9, shows the areas in Communist China where weather control experiments were conducted during 1958–59.

(d) INSTRUMENT RESEARCH — The Communist Chinese produce some of the basic instruments used by the observational network, but they have done very little in the design and development of meteorological research instruments. They have developed a resistance thermometer and a thermocouple anemometer for use in research. It is likely that instrument design research will receive more emphasis with the major research institutes becoming more active in designing instruments to support their research programs.

(2) *Hydrology and hydraulics* — Research in hydrology and hydraulics in Communist China is mainly oriented toward the prevention of floods and the fuller utilization of the tremendous water potential for irrigation and power.

In hydrologic research, Communist China has had to expand its network of gaging stations which was greatly reduced by the end of World War II. River surveys were initiated and, by the end of 1957, the number of precipitation and stream-gaging stations had been increased to more than 6,800.

Three major river surveys are at present undertaken by special groups under the Academy of Sciences: 1) the Amur River Survey, conducted jointly with the Soviet Union; 2) one of the middle reaches of the Yellow River; and 3) a survey for diverting the abundant waters of the southwestern rivers for the irrigation of the arid northwest regions.

The hydrologic problems on certain rivers are investigated for flood protection and better utilization of water resources. The lower course of the Yellow River is under close observation because of the frequent and disastrous floods caused by its shifts; experiments for regulation of the river are being conducted on a small reach. Special interest has been on the study of floods, and a system of hydrologic forecasting has been developed. This system proved to be of value in the 1954 floods of the Yangtze River and in the 1956 floods of the Huai Ho and the Sungari River.

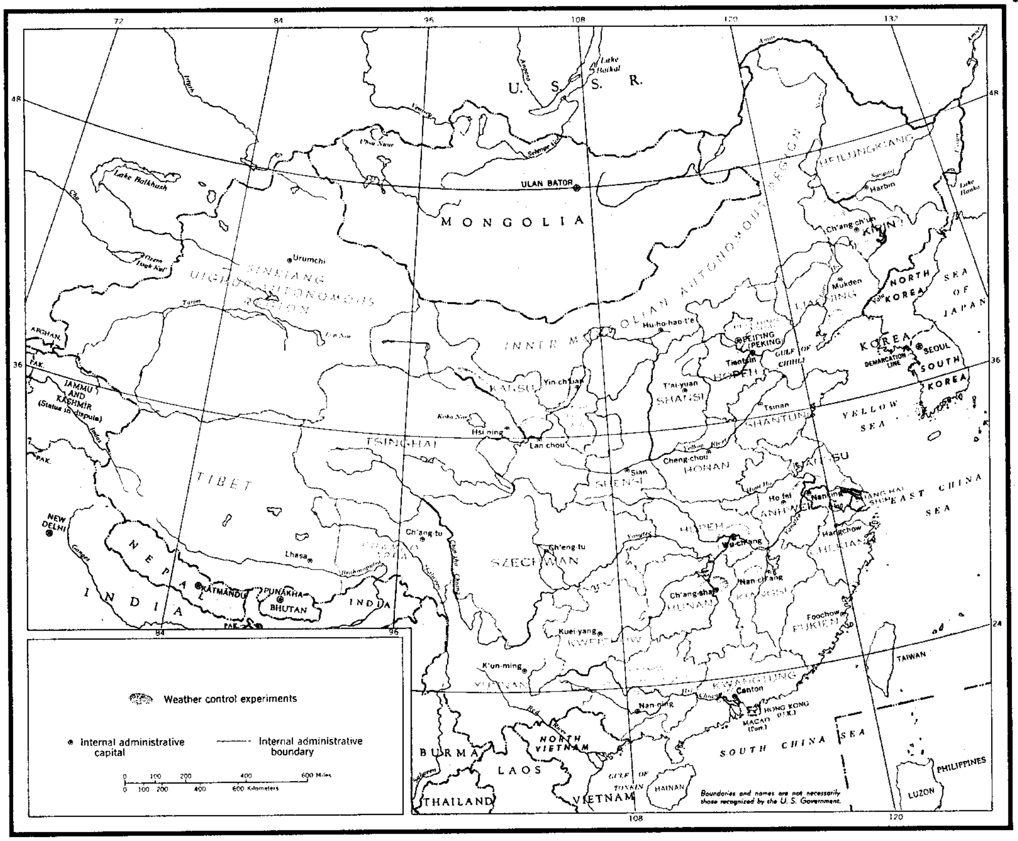

FIGURE 76–9. WEATHER CONTROL EXPERIMENTS CONDUCTED BY COMMUNIST CHINA, 1958–59

One of China's most important hydrologic problems is river silting. River courses changed by silting also have been investigated, as well as the changes caused by the resulting erosion and flooding.

Soil erosion, a significant factor in floods, also is studied. Among the preventive methods under investigation are hydraulic construction and forestation. Research in this field is being carried out in soil mechanics or soil conservation research laboratories and in experiment stations.

Other research activities have been concerned with reservoir evaporation. In the high Ch'i-lien Shan (mountains), the Chinese Communists are attempting to cause earlier runoff by spraying snow and ice with coal ash to provide water for irrigation.

In hydraulic research, dam design and construction are prime targets. The plan for harnessing the Yellow River involves the construction of a series of 46 dams; there is an even more vast plan underway to check the Yangtze in its gorge near San-tou-p'ing. The Chinese often run model tests for their plans. Research and designs reflect the current shortages of construction equipment and of cement and steel.

The problem of seepage is given considerable study. The upstream face of the concrete-arch Fu-tze-ling Dam has been coated with a waterproof compound. The Institute of Hydraulic Research reportedly has developed a material to protect the upstream face of an earth dam, thus decreasing seepage.

Experiments, drawing extensively on Soviet experience, have been made with methods of stream diversion during dam building. Much attention has been given to the stability of dam foundations.

Silting of reservoirs has been an important research problem. The Chinese claim that they have surpassed the United States in this field and that their research has demonstrated new concepts on flow through reservoirs and on the relationship between reservoir inflow and the size and location of outlets for the prevention of sedimentation. Research continues on the improved construction and stability of levees.

Another phase of hydraulic research is concerned with the most effective use of water for irrigation to provide more arable land. Research also is done to determine the best methods for draining saline and alkaline soils.

Since the development of inland navigation is an important aim of the water conservancy program, the best methods are sought for deepening river channels, strengthening banks, and construction of canals, regulators, and locks.

Much research is done on tidal phenomena. Communist China also expects to use tidal power for electric energy and is constructing a tidal power station in Amoy.

The Chinese claim to have developed a number of improved hydraulic measuring instruments, such as a pressure gage, in combination with a computer, that sharply reduces the time required for velocity determination. Other instruments include those that measure the speed and impact pressures of wave pulsations, tidal rise and fall, and wave height. They also claim to have developed an instrument for the supersonic measurements of depths. Automation has been applied to stream gaging at an experimental station on the Yellow River. Here, automatic readings are taken of stage, velocity, and discharge.

c. SIGNIFICANT RESEARCH FACILITIES

Central Institute of Meteorological Research (Chung-yang Ch'i-hsiang Yen-chiu-so), Peiping—Director: Lu Wu in 1957. This institute is subordinate to the Central Meteorological Bureau and, in addition to its research activities, it is the technical center for all forecasting and observational activity in Communist China. It reportedly had 400 employees in mid-1957. The institute conducts some research on observational methods and on meteorological instruments, but its major effort is in synoptic research designed to improve short-period and long-period weather forecasting. It participated in the weather modification experiments along with the Institute of Geophysics and Meteorology, and the coordination and cooperation between these two institutes has been good in other projects as well. Research conducted by the institute has been of average quality, and it is generally inferior to that produced by the Institute of Geophysics and Meteorology.

Hydraulic Research Laboratory, Nanking—This laboratory is under the jurisdiction of the Ministry of Water Conservancy and Electric Power (*Shui-li Tien-li Pu*). It was established about 1935 as the National Hydraulic Research Laboratory. The laboratory is divided into three main departments: Hydraulics, Soil Mechanics, and Construction Materials. Research concerns the design and construction of dams, regulators, sluices, and navigation locks. The problems of seepage through dams and dam foundations have also been studied, as well as energy dissipation in stilling basins, and sedimentation in reservoirs, tidal phenomena, river training, and flood protection. In 1957, this laboratory performed research to increase the capacity of Fu-tze-ling Reservoir and to protect earthfill dams against wave effects. The establishment has two experimental facilities for the study of flow in open channels and several large flumes. It is believed to operate a large outdoor model basin near the mouth of the Yangtze River. Personnel strength has been reported as approximately 200, about half of whom are engineers and technical personnel.

Institute of Geophysics and Meteorology (Ti-ch'iu Wu-li Yen-chiu-so), Peiping—Director: Chao Chiu-chang. This institute, also known as the Institute of Geophysics, is subordinate to the Department of Earth Sciences of the Chinese Academy of Sciences. It is the most important institute in Communist China conducting meteorological research. It has conducted a wide range of meteorological research, but concentrates its major research effort in dynamic meteorology. It has participated in weather modification experiments, and its scientists have led in calling for better designed experiments and for a complementary cloud and precipitation physics research program. In mid-1957, the institute had a research staff of approximately 420 people which included scientists in all the geophysical sciences. Some of the meteorological personnel have studied in the United States and other Western countries and are considered very capable. Because of a general shortage of professional meteorologists in Communist China, the Institute of Geophysics has had to participate in projects which normally would have been done by other groups. Thus, its meteorological staff has not always been used to the best advantage. This institute presently does not have the requisite instruments to conduct research in subfields of meteorology which require complex and nonstandard instrumentation. Very competent meteorological research can be expected from this institute, especially in the subfields of dynamic and physical meteorology, if the requisite instruments are acquired.

Institute of Hydraulic Research (*Shui-li K'o-hsueh Yen-chiu-yuan*), *Peiping*—Director: Hsieh Chia-tseh (reportedly). This institute of the Ministry of Water Conservancy and Electric Power is the largest and most important hydraulic research establishment in Communist China. It is organized into 10 departments of research; of these, hydraulic models, earth mechanics and foundations, reclamation, sand and mud, and hydrologic research are the most significant. It researches all phases of hydrology and hydraulics; some of its major objects of research have included rainfall frequency, flooding, factors affecting drainage, methods for increasing the bearing capacity of earth foundations, currents in rapid streams, the sedimentation problem in the San-men-hsia Reservoir, model tests of river and stream currents and of dams and regulators, and construction methods and materials for hydraulic structures. The institute has experimented with pouring deep units of mass concrete in dam construction and has done much research to prevent seepage in hydraulic structures. Some research has been to devise better hydraulic instruments and equipment. By the end of 1956, the staff was reported to number 500; of these, 160 were college graduates engaged in research. The staff is expected to number about 1,500 within one or two years.

Laboratory of Hydraulic Engineering (*Shui-kung Yen-chiu-shih*), AS, Peiping—This hydraulic research center, with a branch in Nanking, is second in importance to the Hydraulic Research Institute in Peiping. It is organized into three departments concerned with basic and applied research: hydraulic engineering, hydrology and hydraulics, and mud and sand. A major research activity has been a study of the sedimentation problem of the San-men-hsia Reservoir and the preparation of a program for its improvement. The laboratory engages in much research in methods and materials for hydraulic construction. It has carried out field observations on a 140-kilometer (87 miles) reach of the lower Yellow River to determine stage oscillations and erosion. Experiments for regulation of the river are being undertaken on a reach 2.5 kilometers (1.6 miles) long and 150 meters (164 yards) wide, reportedly one of the largest outdoor projects in the world. The Nanking branch has developed a number of electronic instruments to measure wave characteristics. In 1956, the laboratory was reported to have one long flume. Other flumes, a wind tunnel, a water tunnel, and larger laboratory facilities are planned.

Nanking University (*Nan-ching Ta-hsueh*), *Nanking*—Head of the Department of Meteorology: Chu Ping-hai. Under this department are a Division of Meteorology and a Division of Climatology. Some research has been conducted on the effect of reservoirs on meteorological conditions, and the department also cooperated in the weather modification experiments of 1958–59. However, the primary function of the Meteorology Department is training; reportedly in 1957, it had a faculty of eight and a student enrollment of 300. With this ratio, the faculty would have little time for research, but research can be expected to increase as the graduate program becomes more firmly established. Figure 76–10 shows the meteorological observatory, Nanking.

Peiping University (*Pei-ching Ta-hsueh*), *Peiping*—Although the Meteorological Division of the Geophysics Department is concerned primarily with training, its meteorological research program appears to be developed more fully than that of Nanking University. In 1955, Peiping University began to consider the weather modification problem, and was active in the 1958–59 weather modification experiments. Peiping University also has conducted research on the water vapor balance, formation of typhoons, and on the atmospheric circulation. It has cooperated with the Institute of Geophysics and Meteorology in designing the Yangtze River dam, and in flood research projects in preparation for the construction of the San Hsia dam. Meteorological research at Peiping is expected to increase in quantity and in quality, profiting from the rather close working relationship with the Institute of Geophysics and Meteorology.

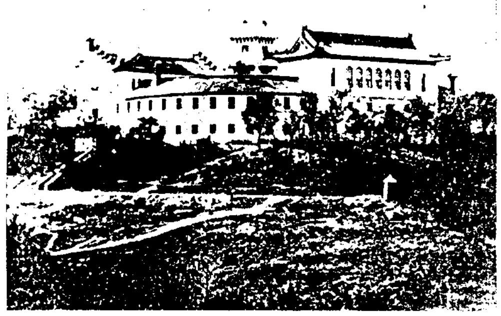

Figure 76–10. Meteorological observatory, Nanking

d. OUTSTANDING PERSONALITIES

CHANG Han-ying (1728/0698/5391), Eng.—Hydraulic engineering. A leading hydraulic engineer in Communist China and probably the top professional expert in the Ministry of Water Conservancy and Electric Power; a vice minister since 1950. Headed a Yellow River survey team in 1951. President of Pei-yang University, Tientsin, 1949–50. Professor at Chung-shan University, Canton, 1946–48. President, Yellow River Conservancy Commission, 1941–43. Director, Hsiang-kuei Waterway Improvement Board, 1938–40. Deputy director, Department of Hydraulic Engineering, National Economic Council, 1936–38. Chief secretary and engineer, Yellow River Conservancy Commission, 1933–36. President, Water Conservancy Society of China. Member, Central Committee of Federation of Natural Science Societies. Attended Second Joint Sino-Soviet Conference on Hydraulic Scientific Technology, Peiping, December 1958. Delegate to Third Congress of World Federation of Scientific Workers, Budapest, September 1953. Studied in the United States in the 1920's and toured the United States in 1945, inspecting flood control projects. Author of several books on water conservation and hydraulic engineering. Born: 1901.

CHANG Kuang-tou (also CHANG Quang-tou) (1728/0342/2435), Prof.—Civil and hydraulic engineering, specializing in hydroelectric power and irrigation structures. He and Professor Hsieh are probably the two foremost hydraulic engineers in Communist China. Member of Standing Committee of Department of Technical Sciences of the Chinese Academy of Sciences and head of Department of Hydraulic Engineering, Hydraulic Research Laboratory of the academy. Professor of Hydraulic Engineering and head of research unit on hydroelectric structures, Department of Water Conservancy, Tsinghua University, Peiping, 1954–56. Assistant chief engineer, National Hydroelectric Engineering Administration, and engineer, Lung-hsi River Hydroelectric Plant, 1947. Engineer and head, Shan Tou River Hydroelectric Plant, 1940–43. Associate engineer, National Resources Commission, 1937–38. Studied in the United States in the 1930's; employed as a junior engineer, Bureau of Reclamation, Denver, 1936–37 and 1943–47. Member of scientific and technological delegation to the U.S.S.R. in 1957. Author of several papers. Has openly advocated Communism since 1947. Born: 1912.

CHAO Chiu-chang (6392/0046/4545), Dr.—Dynamic meteorology. Director, Institute of Geophysics and Meteorology, AS, since 1954. Member of the Standing Committee, Board of Directors, Meteorological Society of China. Chairman of the Board, Geophysical Society of China, 1957. Vice chairman, Communist Chinese National Committee for the IGY. Director, Institute of Meteorology, 1946. Professor of Meteorology, Tsinghua University, 1937–44. Studied at the University of Berlin, 1935, and lectured in the United States in 1946. Visited the U.S.S.R. in 1953, Japan in 1957, and India in 1960. In 1954, reported to be unsympathetic to the Communist cause. Current duties are chiefly administrative, but has conducted research on the general atmospheric circulation, the thermodynamics of monsoons, and the frictional effects on atmospheric motion. Born: 1907.

CHU K'o-chen (4555/0668/1506), Dr.—Meteorology and climatology. Regarded as the founder of scientific climatology in China. Vice president, Communist Chinese Academy of Sciences, 1958. Chancellor, National Chekiang University, 1936–49. Director, Institute of Meteorology, *Academia Sinica*, 1928–46. Chairman, China Meteorological Society, 1958. Member, Board of Directors, China Society of Astronomy. Head of Academy of Sciences Planning Bureau which organized the Institute of Physics and the Institute of Applied Physics. Studied in the United States, receiving his doctorate at Harvard University. Formerly, member of Chinese Nationalist Party but was expelled in 1949. Active propagandist on alleged U.S. use of biological warfare during Korean War. Recent duties are chiefly administrative. Has conducted research on monsoons, typhoons, and climatology of China. Born: 1890.

CHU Ping-hai, Prof.—Synoptic meteorology and climatology. Head, Department of Meteorology, Nanking University, since 1955. Associate professor, Department of Geography, National Central University, 1942. Treasurer, Geographical Society of China, 1942. Director, Wuhan Regional Planning Committee, 1946. Member, Board of Directors, Chinese Meteorological Society, 1953. Has directed research in precipitation distribution, water vapor circulation, atmospheric circulation, and climatology.

HSIEH, Chia-tseh, Prof.—Hydraulic engineering and hydrology. He and Professor Chang Kuang-tou are probably the two foremost hydraulic engineers in Communist China. Reportedly, director of the Hydraulic Research Institute of the Ministry of Water Conservancy and Electric Power and possibly also director of the ministry's Bureau of Hydrology (was appointed in 1950). Chief of the hydrological detachment of the Chinese expedition on the Sino-Soviet Survey of the Amur River. Member of the National Hydroelectric Engineering Bureau, Nanking, 1950. Professor of Hydraulic Engineering, National Central University, 1940–48. Member of Yellow River Board of Studies, 1946–47, and helped write the board's multivolume report. Studied in Germany, 1939. Assistant professor, Tsinghua University, Peiping, 1934–35. Has made detailed studies on the hydrology, drainage, and flood problems of the Yellow and Yangtze Rivers; reportedly, has recently taken a prominent part in investigating the sedimentation problem at the San-men-hsia Reservoir. Has written numerous books, reports, and articles on many aspects of hydrology and hydraulic engineering. Born: 1911.

HSU Erh-hao, Prof.—Dynamic meteorology; leader in Communist Chinese research on general atmospheric circulation. Faculty member, Department of Meteorology, Nanking University, since 1953. Member, Compilation and Translation Committee, Meteorological Society of China, 1953. Has conducted research on atmospheric energy distribution, atmospheric diffusion, vorticity distribution, and numerical weather prediction.

KU Chen-ch'ao, Prof. Dr.—Dynamic meteorology; leading Communist Chinese researcher in numerical weather prediction. Member, Institute of Geophysics and Meteorology, Communist Chinese Academy of Sciences, since at least 1955. Associated with Central Meteorological Observatory, Peiping, 1950. Associated with University of Stockholm, 1948–50. Member, Compilation and Translation Committee, Meteorological Society of China, 1953. Member, Standing Committee, Board of Directors, Meteorological Society of China, 1953. Studied at the University of Stockholm, and attended the Numerical Weather Prediction Conference at Stockholm, Sweden, 1957. Has conducted research on atmospheric circulation, heat exchange between oceans and continents, effects of the Tibetan Plateau on the atmospheric circulation, and numerical weather prediction.

LU Wu (4151/6909)—Synoptic meteorology. Deputy director, Central Meteorological Bureau and director, Central Institute of Meteorological Research, 1957. Secretary, Editorial Committee of Scientific Papers on Meteorology, AS, 1959. Member, Compilation and Translation Committee, Meteorological Society of China, 1953. Has conducted research on the monthly pressure distribution in the Far East, cold outbreaks, distribution of precipitation, and climatology. Born: 1911.

T'U Ch'ang-wang (3205/7022/2598), Prof.—Synoptic meteorology. Secretary, AS, 1953. Director, Central Meteorological Bureau, since at least 1953. Director, Central Meteorological Observatory, 1950. Vice chairman, Meteorological Society of China, 1959. Member, Communist Chinese National Committee for the IGY. Secretary General, National Association of Scientific Workers, 1948. General manager, provisional board of directors, Chinese Science Workers' Association, 1949. Member, Executive Council, World Federation of Scientific Workers, 1951. Member of Executive Board, Sino-Soviet Friendship Association. Has visited the United Kingdom in 1950, Poland in 1950, U.S.S.R. in 1950, and Austria in 1952. Reported to be a Communist. Has conducted research on monsoons, floods, and droughts in China. Date of birth unknown.

WANG Hu-chen—Civil and hydraulic engineering. One of the foremost Chinese hydraulic engineers in the field of dam building. Member of the Department of Technical Sciences, Academy of Sciences. Reportedly, chief engineer, San-men-hsia Construction Bureau, in 1959, and chief engineer, Designing Department, Ministry of Water Conservancy and Electric Power, 1955. Director, Fu-tze-ling reservoir construction, 1954. Deputy director, Department of Water Conservancy, East China Military and Administrative Committee, and deputy chief, Engineering Bureau, Huai Ho Conservancy Commission, 1950. Director, Bureau of Engineering, All-China Economic Association. Chief engineer of planning committee of Huai Ho Conservancy Commission. Chief of Engineering Section, Bureau of Irrigation, Chekiang province. Technician, T'-ai-hu Irrigation Section. Member of executive committee of the Civil Engineering Society of China. Delegate to scientific meetings in India, December 1954 and April 1955; Pakistan, January 1955; and Japan, December 1955. Studied in the United States. Has done much research and has published numerous papers on the design and construction of hydraulic structures and methods of stream diversion. Born: 1894.

YEH Tu-cheng, Prof.—Dynamic meteorology. Affiliated with the Institute of Geophysics and Meteorology since at least 1953. Professor of Meteorology, Peiping University, since 1954. Member, Secretariat, AS, 1953. Member, Board of Directors and of the Compilation and Translation Committee, Meteorological Society of China, 1953. Affiliated with the University of Chicago, 1945–50. Speaks English; reads English and German. Has conducted research covering a wide range of dynamic and physical meteorological subfields including atmospheric electricity, cloud physics and weather modification, topographic and thermal influence of land and sea distribution on the general circulation, influence of the Tibetan Plateau on the general circulation, distribution and production of kinetic energy in the atmospheric circulation, the jet stream, and the variation and transfer of angular momentum. Born: 1916.

3. Oceanography

a. GENERAL

(1) *Capabilities and trends* — Oceanography is in an incipient stage in Communist China. The country is not expected to make any significant progress in this field in the near future. Capability in this field is extremely low, especially when compared with that of other nations actively engaged in such research—particularly, Japan and the Soviet Union, also active in oceanographic research in the Far East. Because Communist China lacks sufficient well-trained oceanographic personnel, most research has been routine, in support of marine biology and fisheries to satisfy domestic needs for marine products. Other areas of research have been neglected, such as marine physics, chemistry, geology, and instrumentation. Existing facilities are unsuitable, primarily because they lack adequate instrumentation and are concentrated in the Tsingtao area.

The existing limitations in oceanography are recognized, and the objectives of the present research program include plans for strengthening the capabilities in physical, chemical, and geological oceanography. With the strength of the Communist Chinese Navy gradually increasing, greater emphasis can be expected in these nonbiological aspects of oceanography. Much of the present Communist Chinese effort is directed toward the expansion of research facilities and the domestic training of oceanographers to establish a better research program.

Internationally, Communist Chinese oceanographers have been practically isolated from scientific activities which could help promote the country's program. Most foreign contacts in this field have been with oceanographers from other Communist countries. As a member of the Fisheries' Research Commission for the Western Pacific, which has a section for investigating the oceanography of the Yellow, East China and South China Seas, Communist China has been collaborating in the oceanographic study of Far Eastern waters with the Soviet Union, North Korea, and North and South Vietnam. The current trend is toward closer cooperation with the U.S.S.R., which has furnished assistance in the form of advisers and has provided shipboard experience for Chinese oceanographers aboard Soviet research ships. Participation in broader international investigations probably will continue to be extremely limited until the scientific capabilities of Communist China in oceanography increase.

(2) *Background and organization* — Prior to 1949, when the Communist regime took over the mainland, oceanographic research in China

was conducted on a small scale at marine biological stations and at the Tsingtao marine biological laboratory. This effort was very inadequate for a country with a coastline of more than 8,500 miles and with a need for marine resources as a source of food. Under the Communist regime, the potential of oceanographic research to support the exploitation of marine resources was recognized early and, with technical aid from the U.S.S.R., the scientific effort in oceanography has been undergoing continuous expansion.

The most important oceanographic research in Communist China is being conducted at institutions of the Academy of Sciences (*Chung-kuo K'o-hsueh-yuan*), AS, Peiping, and the Ministry of Marine Products (*Shui-ch'an Pu*). The Institute of Oceanography (*Hai-yang Yen-chiu-so*), Tsingtao, established by the academy as a small marine biological laboratory at Tsingtao in 1950, is now the leading oceanographic research organization. The academy also conducts limited oceanographic research at its Institute of Geophysics and Meteorology (*Ti-ch'iu Wu-li Yen-chiu-so*), Peiping, and plans to supplement the work of the Institute of Oceanography by establishing a similar organization under its Canton Branch to study the South China Sea. The Ministry of Marine Products maintains research institutes at Tsingtao, Shanghai, and Canton. These institutes, of which the Institute of Aquatic Products of the Yellow Sea (*Huang-hai Shui-ch'an Yen-chiu-so*) in Tsingtao is believed to be the most important, conduct oceanographic surveys to support fisheries research. Other Communist Chinese organizations concerned with oceanography include the educational institutions of Amoy University (*Hsia-men Ta-hsueh*), Amoy, and the Shantung College of Oceanography (*Shan-tung Hai-yang Hsueh-yuan*) at Tsingtao, as well as the Fukien Institute of Oceanography (*Fu-chien Hai-yang Yen-chiu-so*) at Amoy, the Central Meteorological Bureau (*Chung-yang Ch'i-hsiang Chu*), and facilities of the Chinese Communist Navy. The research efforts of these various organizations are planned and controlled nationally by the Department of Oceanography in the (State) Scientific and Technological Commission (*K'o-hsueh Chi-shu Wei-yuan-hui*) under the State Council (*Kuo-wu Yuan*).

While a major portion of the Chinese effort has been devoted to acquiring and organizing research facilities, the most immediate task has been the domestic training of personnel. The total number of domestic and foreign trained Chinese oceanographers, exclusive of marine biologists, is believed to be less than 150 and probably less than 10 of these are capable of conducting significant independent research. These few leading oceanographers received their training in Western countries and are the cadre to train oceanographers. Some foreign educational aid is being obtained from the Soviet Union, but the Shantung College of Oceanography in Tsingtao, established in 1959, apparently has the major responsibility for the training program.

The Soviet Union has provided limited technical assistance to Communist China during the first decade of development of the country's oceanographic research program. Leading Soviet oceanographers have been sent to Communist China as observers to promote research. The oceanographic instrumentation furnished to China was produced in the Soviet Union and was standard instrumentation for routine observations. Long-term technical aid apparently will continue to be received from the Soviet Union through joint oceanographic surveys of Far Eastern waters sponsored by the Fisheries' Research Commission for the Western Pacific. Soviet and Chinese scientists and ships have been cooperating in surveys of the Yellow Sea since formation of the commission in 1956. Considering Soviet capabilities in shipboard research, the Chinese effort should benefit from these joint efforts. Possibly, Chinese oceanographers will also participate on Soviet oceanographic cruises that are part of international programs, as they did aboard the *Vityaz* during the International Geophysical Year (IGY). However, Communist China in general is expected to confine its research to domestic waters and not to become a major participant in international oceanographic programs such as the International Indian Ocean Expedition.

b. MAJOR RESEARCH AND DEVELOPMENT — At present, oceanographic research in Communist China is limited primarily to studies of the littoral regions and to marine biological investigations. Most of the present research is conducted by institutes in the Tsingtao area and particularly by the Institute of Oceanography. The shortages of trained personnel and adequate equipment, however, have restricted the research effort to a routine data collection activity. The present research program is organized primarily around a series of systematic surveys of territorial waters and at least some of them are part of the fisheries and oceanography investigations of the Yellow, East China and South China Seas sponsored by the Fisheries' Research Commission for the Western Pacific. There are three known research ships and apparently the Chinese Navy provide ships to support the various survey activities.

From 1953 to 1956 the Po Hai and Yellow Sea were investigated. These initial surveys were then followed by a group of synoptic investigations in the same area during the period from June 1957 to August 1958. More extensive surveys are now being conducted in the Yellow, East China and South China Seas and should be completed by the end of 1960. These various surveys have collected information about the spatial and temporal variations of the oceanographic characteristics of Chinese waters and have served to train young oceanographers. No advanced research programs are evident; however, other research in physical oceanography has included a study of tidal conditions in the Po Hai, and a tide table of the area has been compiled. Ocean wave recorders and a wave spectrum analyzer have been developed and are being used to collect data for perfecting a semi-empirical method of wave forecasting. A chart of the bottom sediments in the East China Sea and southern part of the Yellow Sea has been compiled by the staff of the Institute of Oceanography. The erosion and silting of harbors is also being studied. Apparently, the Soviet marine geologist V. P. Zenkovich, who specializes in beach and coastal problems, was associated with this research during his recent stay in China. Other types of marine geological investigations, such as marine seismology, gravimetry and geomagnetism, have not yet been developed.

The marine biological and fisheries research, the strongest area in the Chinese program, has been devoted to the systematic surveying of marine resources in coastal waters and has included studies of the morphology, ecology, life history and food value of selected groups of marine flora and fauna. The results are compiled and published by the Institute of Oceanography. The institute is also conducting notable research on marine algae. This work is directed by Dr. Tseng Ch'eng K'uei, who is considered to be one of the outstanding workers in the world on this subject. Other research is centered mostly at the Institute of Aquatic Products of the Yellow Sea and has a direct application to marine industries. This work includes determination of reserves of sea resources, breeding of marine organisms, utilization and processing of marine products, and saltwater pisciculture.

c. Significant research facilities

Fukien Institute of Oceanography (*Fu-chien Hai-yang Yen-chiu-so*), *Amoy University, Amoy*—Director: Shen Chia-jui in 1958. This institute was organized in late 1959. It is believed to have been formed from the Laboratory of Marine Biology of Amoy University. Though little is known about this facility, its reorganization suggests possible increased study of the Chinese Communist waters in the Formosa Strait.

Institute of Aquatic Products of the Yellow Sea (*Huang-hai Shui-ch'an Yen-chiu-so*), *Tsingtao*—Director: unknown. Established in 1951, as the Central Institute of Aquatic Products under the Ministry of Marine Products, this institute is believed to have been reorganized by 1959. Though this institute is concerned with fisheries research, it apparently conducts oceanographic surveys in support of the fishing industry.

Institute of Oceanography (*Hai-yang Yen-chiu-so*), *Academy of Sciences, Tsingtao*—Director: T'ung Ti-chou in 1957. Established in 1950 as the Marine Biological Laboratory at Tsingtao and subordinate to the Hydrobiological Institute of the academy, this organization was expanded and by 1957 became a separate institute, known as the Institute of Marine Biology. Subsequently, the academy further expanded the institute and its oceanographic research program and, on 1 January 1959, established it as the Institute of Oceanography. The institute has departments of physical oceanography, marine geology and marine biology. The institute is now the largest center of oceanographic research in Communist China. The original staff of the laboratory grew from 32 to 329 within the first seven years. Eventually, the institute is expected to have a staff of 600 persons and occupy three buildings.

A major portion of the research concerns the investigation of oceanographic conditions in Chinese coastal waters and the collection of data about marine resources. Although this work is routine and generally of low scientific caliber, it is probably the best in the country, as the staff includes many of the leading Chinese oceanographers. The institute is expected to stress the marine biological aspects, for at least nine of the fourteen members on the Scientific Committee formed at the institute in 1958 were biologists. The present facilities include a library of more than 4,000 volumes, two ships—the 930-ton *Venus* and 109-ton *Mercury*—and aquariums. Workshops are also apparently available for developing and constructing instruments.

Shantung College of Oceanography (*Shan-tung Hai-yang Ysueh-yuan*), *Tsingtao*—President: unknown. This college, believed to be subordinate to the Ministry of Education, was founded in 1959 to provide training in theoretical oceanographic research and in the techniques of marine production. It was established from the Department of

Oceanography and sections of other departments of the Shantung University concerned with the marine sciences. The college has departments of marine meteorology, physics, chemistry and biology, and marine products. Neither the size of the facility nor student body is known; but, since this is the first such institute in Communist China, it probably will be the leading education organization for oceanographers in the country.

d. OUTSTANDING PERSONALITIES

HO Ch'ung-pen, Dr.—Physical oceanography. Professor of Oceanography at Shantung University in 1956 and 1957. A member of the Scientific Committee of the Institute of Oceanography (formerly, the Institute of Marine Biology) in 1958. Serves as vice director of the Oceanography Section of the Fisheries' Research Commission for the Western Pacific. Studied in the United States from 1944–49 and received a Ph.D. in meteorology from the California Institute of Technology. Recent research has concerned the physical oceanography of seas bordering Communist China. Born: 11 October 1910.

MAO Han-li (3029/3352/4409), Dr.—Physical oceanography. Dr. Mao is considered to be the best trained oceanographer in Communist China. Head of the physical oceanography department of the Institute of Oceanography and a member of its Scientific Committee in 1958. Studied in the United States from 1947–51 and received a Ph.D. in oceanography from the Scripps Institute of Oceanography, University of California. Born: 28 December 1919.

TSENG Ch'eng-k'uei (2582/0701/1145), Dr.—Marine biology. Dr. Tseng is internationally known for his research on marine algae. He has been associated with the Institute of Oceanography and its predecessor, the Institute of Marine Biology, since 1950: as the executive director, 1950–52; a department head, 1956; a member of the Scientific Committee, 1958; and the vice president of the Institute of Oceanography, 1959. Associated with Shantung University, 1947–58. A member of the educational board of *Acta Botanica Sinica* (Botanical Science Acts) in 1954 and the board of directors of the China Oceanography and Limnology Society in 1956. Studied and worked in the United States, 1940–47, and received a D.Sc. at the University of Michigan in 1942. Traveled to Germany and the U.S.S.R. in 1951. Recent research has concerned the biochemical aspects of marine algae. Born: 18 June 1909.

T'UNG Ti-chou (4547/4574/0719), Dr.—Experimental embryology. Dr. T'ung has been director of the Institute of Oceanography and its predecessor, the Institute of Marine Biology since 1951. He is also the director of the Department of Biology in the Chinese Academy of Sciences and on the board of directors of the China Oceanography and Limnology Society. Serves as secretary of the Fisheries' Research Commission for the Western Pacific. He traveled and studied in the United Kingdom in 1934, in Belgium where he received a D.Sc. from the University of Brussels in 1934, in the United States in 1948 and 1949, and in the Soviet Union in 1957. Born: 1902.

4. Terrestrial geophysics and geodesy

a. GENERAL

(1) *Capabilities and trends* — Research in terrestrial geophysics and geodesy has increased greatly since the Communist regime began in 1949. The largest gains in the geodetic, gravimetric, geoelectric, geomagnetic, and seismological sciences have been those associated with the applied aspects of the sciences, such as mineral prospecting, mapping, and other related problems. Despite considerable progress, the Chinese work in these fields is not really outstanding, or even adequate, to meet domestic needs. Nevertheless, with a great deal of foreign help, mainly from the U.S.S.R., important gains have been made in the last ten years. Of the terrestrial sciences, geodesy and, particularly seismology, are the most developed in Communist China, while work lags in gravimetry, geomagnetism, and geoelectricity. In their very intense determination to become self-sufficient, the Communist Chinese have almost exclusively emphasized the applied sciences, to the detriment of basic and theoretical studies. Although gains have been made, research in terrestrial geophysics and geodesy still fails to meet the economic and military needs of a country of the size and importance of Communist China.

Research facilities for use in these sciences are still inadequate. Although considerable expansion has taken place in new geophysical training centers and research institutes, there is still a shortage of adequate research facilities in the field; however, the most fundamental and crucial shortage is a lack of well-trained personnel, coupled with gross inefficiencies in the use of existing personnel.

The scientific capabilities of the Chinese Communists in the geophysical sciences have been rising sharply during most of the last ten years. New geophysical stations and observatories are being built that will provide better regional and areal data collection facilities, particularly earthquake and explosion recording stations in the field of seismology. The degree of Soviet interest in seismological detection of manmade explosions and the sizable Soviet seismological support to Communist China, makes it quite probable that the Soviet Union has cooperated with the Chinese Communists in developing a capability for recording and reporting the West's nuclear tests, particularly those in the western Pacific area. Terrestrial geophysics and geodesy, as applied to mineral exploration and exploitation, military cartography, flood control and other engineering and development projects, are being expanded and improved each year for the military scientific and economic strengthening of the country.

The degree to which Chinese Communist geophysics gains from the West is probably relatively low. Chinese Communist geophysicists and geodesists have only rarely attended international meetings in Western countries, and when they did, their participation was almost nonexistent.

(2) *Background and organization* — Chinese investigators were among the first to study earthquake seismology and the earth's geomagnetic field, but they advanced the science only slightly until the end of the Kuomintang (Nationalist) regime in 1949. For the past two hundred years, the main emphasis for geophysical and geodetic research in China has come from foreigners. In the early 18th century or before, the Jesuits began to make astronomical and geophysical observations in many parts of China and Mongolia. The astronomic data, although grossly inaccurate, served as the basic control for much of the early mapping of China. Even today, these old surveys constitute the only available control in certain parts of the country.

During the 19th century, the British Admiralty Office established fourth-order triangulation along the coast of China from Hong Kong to Shanghai. Most British and U.S. hydrographic charts are based on these surveys. The Peiping Central Army Survey School began geodetic surveys in 1907. The school established first-order leveling between Peiping and Ch'eng-tu and some first-order triangulation in Hopeh province.

The Chinese Nationalists established triangulation, traverse, and leveling nets and made astronomic observations over much of China between 1912 and 1948. Although most of the surveyed areas were covered only by lower-order control, first-order control did exist in several scattered areas, the largest of which included all of Chekiang and parts of the adjacent provinces. Other important works by the Nationalist Chinese included geodetic surveys of several of the major rivers by the various river and conservancy commissions, the Chinese maritime customs, and the Chinese hydrographic office.

Most of the available topographic maps of China, excluding Manchuria, are based on Nationalist Chinese surveys, the results of which are computed in terms of a number of local geodetic datums. During their occupation of Manchuria (1931–44), the Japanese established good quality geodetic surveys that covered much of the region. This geodetic work reportedly is unavailable to the Communists. During the Sino-Japanese War (197–45), the Japanese established numerous small lower-order surveys, based on local astrofixes, to meet military requirements throughout the occupied area of China.

The measurement of gravity in China was begun by Father Pierre Lejay of the Zikawei Observatory (*Hsu-chia-hui T'ien-wen-t'ai*), Shanghai, who established 167 gravity stations in various parts of China between September 1944 and February 1935, using the observatory as the base. Seventy more gravity stations were established between Shanghai and K'un-ming and in western Yünnan province from 1937 to 1939 by the Chinese Academy of Sciences. During June and July 1948, the Chinese Petroleum Corporation established 163 gravity stations in Shanghai. At about the same time, Eric Norin and Nils Ambolt conducted a gravity survey in the Tarim Basin, making 48 measurements by pendulum.

Although much of the geomagnetic and seismological research was being conducted by French Jesuits, some work also was being done by other nationalities as well. The Chinese themselves also had two or three observatories for making these geophysical measurements and observations.

Since the Communist regime has attained power, there has been a greatly increased emphasis in applied geophysics to further the economic and military growth of the country. The Academy of Sciences exercises primary control over basic and theoretical research in terrestrial geophysics in Communist China. The Ministry of Geology (*Ti-chih Pu*) is the main controlling organization in applied terrestrial geophysics, but the Academy of Sciences (*Chung-kuo K'o-hsueh-yuan*), AS, Peiping, and several of the various industrial ministries also exert considerable influence over geophysical research and operations in the applied fields. In the fields of geodesy and mapping, the State Bureau of Surveying and Cartography (*Kuo-chia Ts'e Ts'e-hui Tsung-chu*), Peiping, is the responsible organization. The work of these and other controlling bodies is coordinated for the State Council by the (State) Scientific and Technological Commission. FIGURE 76–11 shows the probable subordination of Chinese Communist organizations concerned with terrestrial geophysics.

General control of basic and theoretical research in geophysics is centered in the Department of Earth Sciences under the Academy of Sciences. To the extent that applied geophysics is controlled by the academy, that too is controlled under the Department of Earth Sciences and organizations such as the academy's Interdepartmental Council on Seismology.

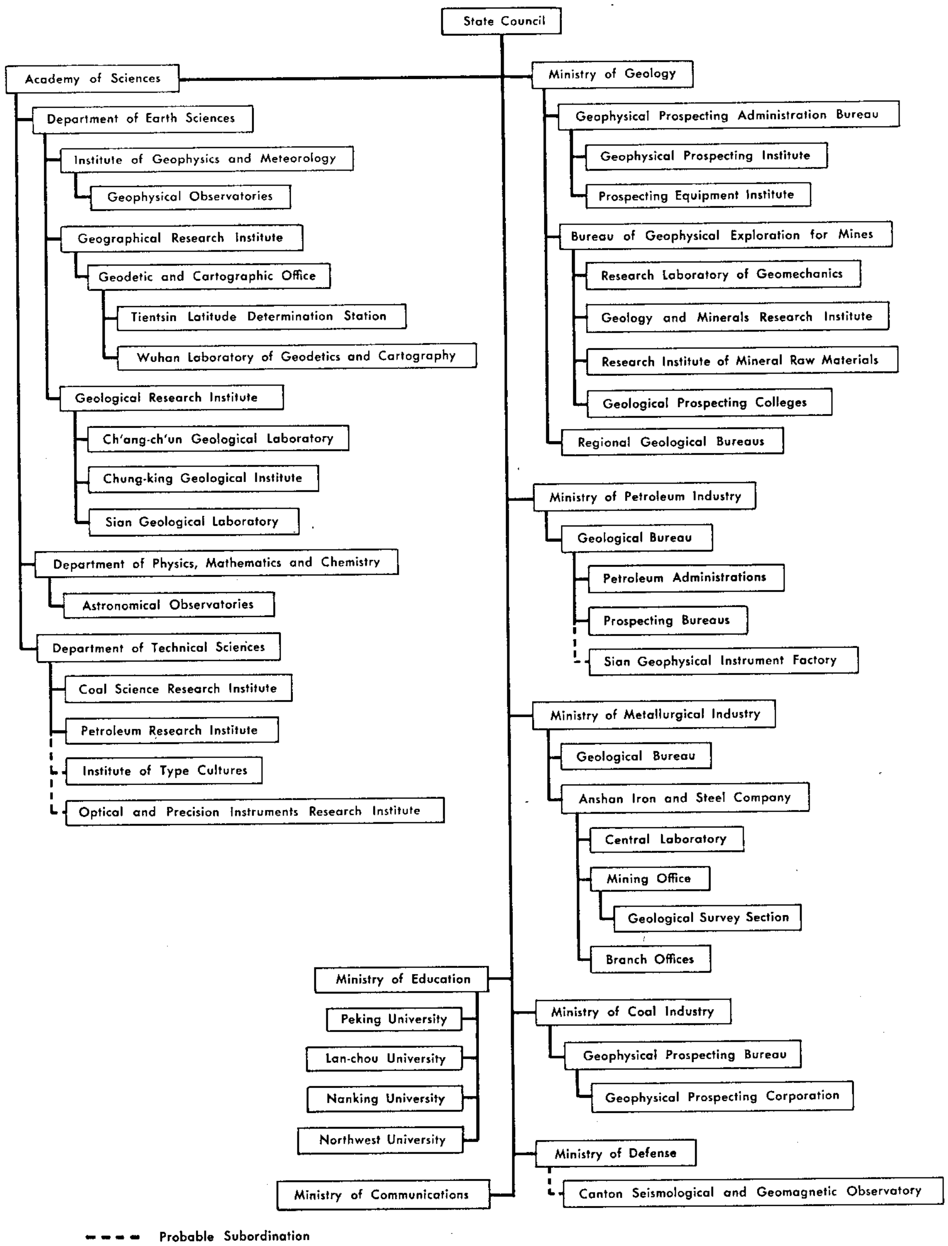

FIGURE 76–11. PROBABLE SUBORDINATION OF CHINESE COMMUNIST ORGANIZATIONS CONCERNED WITH TERRESTRIAL GEOPHYSICS

The State Bureau of Surveying and Cartography* (*Kuo-chia Ts'e Ts'e-hui Tsung-chu*), Peiping, is directed by Li T'ing-tsan. The bureau, established 23 January 1956, is directly subordinate to the State Council. It oversees a number of geodetic and areal survey teams in the field, including a radar (Shoran**) survey team, a geodesy and cartography publishing agency, and a map publishing agency, and known branch bureaus in Harbin and Sian.

The bureau is directly responsible for all geodetic and cartographic work in Communist China. The capabilities of the personnel and the scope and progress of its current geodetic research activities are not fully known. Geodetic instruments in use are known to include standard European equipment of excellent quality; instruments of similar quality constructed in the U.S.S.R.; and instruments of recent Chinese design and manufacture which are probably inferior.

The State Bureau of Surveying and Cartography is charged with: 1) the compilation of unified annual and perspective plans for the geodetic, gravimetric, photogrammetric, cartographic, and map publishing operations in the country; 2) development of unified instructions, direction and conventional signs for use in topographic, geodetic, and cartographic work; 3) performance of basic geodetic and gravimetric work and topographic surveys; 4) ensuring unified methodical supervision of topographic and geodetic work, performed by the various organizations engaged in economic construction and the regulation and reception of the work of these organizations; 5) gathering, recording, systemizing, analyzing, and storing astronomical, geodetic, gravimetric, photogrammetric and cartographic materials, and map originals; 6) compilation and publication of scientific and technical literature on geodesy, photogrammetry, and cartography and publication of catalogs listing coordinates of geodetic points and maps of various scales and purposes; 7) training technical personnel in the geodetic, photogrammetric, cartographic, and map publishing specialties and assisting educational institutions in training personnel in the topographic geodetic specialty; 8) organization of scientific research in geodesy and cartography; and 9) assisting instrument manufacturing plants in the production of experimental geodetic, photogrammetric instruments and devices.

Since its organization in 1952, the Ministry of Geology has had primary responsibility for geophysical and geological prospecting in Communist China. One of the fundamental assignments of the Ministry of Geology during the First Five Year Plan (1953–57) was to provide the state with its needs in mineral raw materials for industry and capital construction projects. Such tasks are carried out for the Ministry of Geology by the Geophysical Prospecting Administration Bureau, which has eight branch offices in various sections of the country.

The Bureau of Surveying and Cartography of the Ministry of Geology (*Ts'e-hui Chu Ti-chih Pu*), Peiping, has primary responsibility for surveying and mapping within the Ministry of Geology. Plans, programs, and specifications for geodetic and topographic surveys are coordinated with the Bureau of Surveying and Cartography. In 1957, the bureau completed geodetic surveys in Tsingtao, Kansu, Szechwan, and the Inner Mongolian Autonomous Region, covering a total of 281,000 square kilometers.

Several of the industrial ministries, such as those concerned with petroleum, coal, and metallurgy, also maintain strong interests in mineral exploration. The Ministry of Petroleum Industry (*Shih-yu Kung-yeh Pu*) has a Geological Bureau that administers its prospecting activities and actively cooperates with Ministry of Geology (*Ti-chih Pu*) components in searching for oil deposits. The Ministry of Coal Industry (*Mei-t'an Kung-yeh Pu*) has a Geophysical Prospecting Bureau that controls geophysical prospecting corporations at survey sites around the country. The Ministry of Metallurgical Industry (*Yen-chin Kung-yeh Pu*) has a Geological Bureau with five subordinate branch offices that administers most of the ministry's geophysical prospecting work. Also subordinate to this ministry is the Anshan Iron and Steel Company, which does geophysical prospecting research and has two major divisions directly concerned with mineral prospecting. Other ministries guiding related work are the Ministry of Education (*Chiao-yu Pu*), which controls the universities and polytechnical institutes, and the Ministry of Communications (*Chiao-t'ung Pu*), which has been providing aircraft and related facilities for airborne geophysical surveys since early 1958.

The Bureau of Surveying and Cartography of the General Staff (*Tsung-ts'an Ts'e-hui Chu*), Peiping, is responsible for conducting geodetic and

* Other names for this bureau include: National Bureau of Surveying and Cartography, National Survey and Mapping Bureau of the State Council, State Surveying General Bureau, Central State Survey and Cartography Bureau, State General Bureau of Survey and Drafting, Main Administration of Geodesy and Cartography.

** Shoran (Short range navigation)—A system of short range navigation in which radar signals transmitted by an airplane are intercepted and rebroadcast by two ground stations of known position, and utilized to determine the range of the aircraft from each station.

cartographic research for the military services. It probably cooperates with the State Bureau of Surveying and Cartography in the establishment of geodetic and gravimetric surveys, and in the compilation of survey standards and specifications and technical manuals.

The promotion of Chinese geodesy and cartography is being done by the Chinese Society of Geodesy and Cartography (*Chung-kuo Ts'e-hui Hsueh-hui*), Peiping. This organization was founded in June 1956 and was reorganized in February 1959. The society is a member of the Scientific and Technical Association of the People's Republic of China. In 1958, the society had approximately 600 members with branches being organized in Canton, Harbin, Ch'ang-ch'un, and Mukden. Branch societies have been formed in Peiping, Shanghai, Tientsin, and Wu-han. The society encourages members to participate in and promote geodetic and cartographic scientific work, and organizes the exchange of scientific and technological data. The activities of the society include astronomic, gravimetric, geodetic, hydrographic, and aerial photo surveys, terrain studies, engineering projects, cartographic activities, and editing and compiling of the quarterly Chinese *Geodetic and Cartographic Journal* and the *Geodetic and Cartographic Translations*.

b. MAJOR RESEARCH AND DEVELOPMENT BY FIELD — Applied research is strongly emphasized in Communist China to the detriment of basic and theoretical research. The major applications of terrestrial geophysics include mineral prospecting, earthquake-resistant construction, development of geophysical devices and systems for various detection and communications purposes, and gravimetric research for improved geodetic and cartographic coverage. FIGURE 76–12 shows the loca-

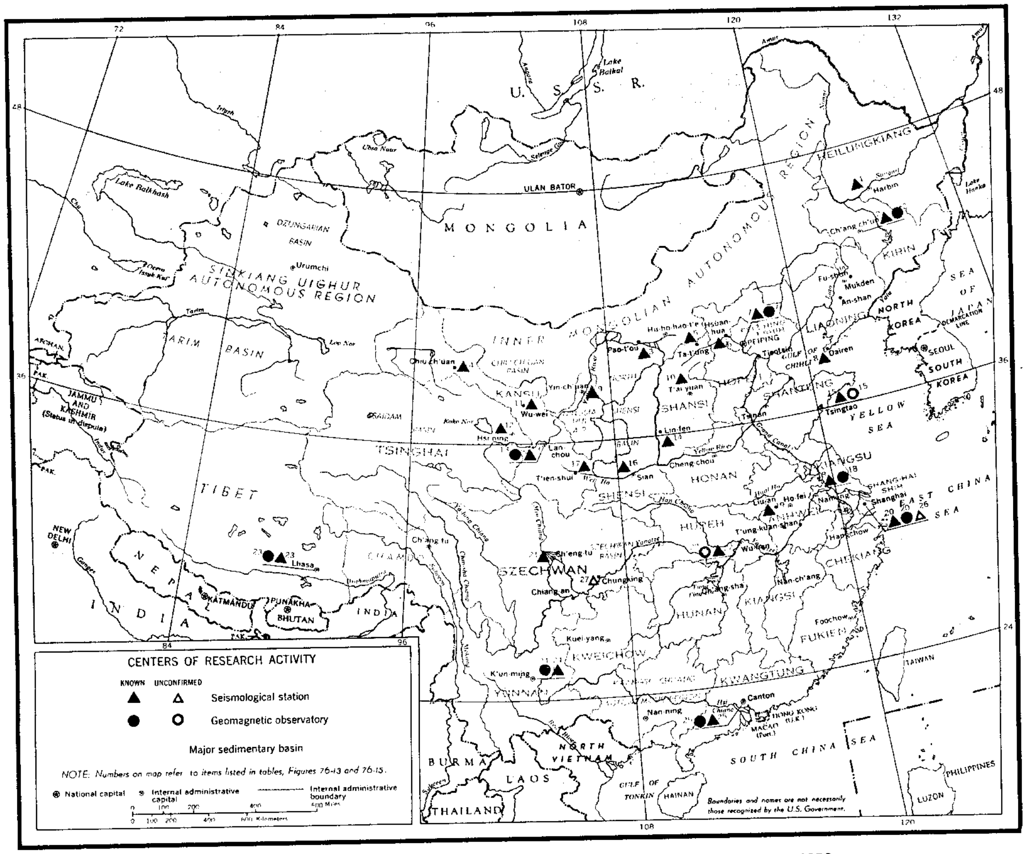

FIGURE 76–12. CENTERS OF RESEARCH ACTIVITY IN TERRESTRIAL GEOPHYSICS, 1958

tion of research activity in terrestrial geophysics in Communist China in 1958.

The Chinese Communists originally planned to participate in the International Geophysical Year (IGY), 1957–58; however, the appearance of the Nationalist Chinese from Taiwan led the Chinese Communists to issue an ultimatum to the Special IGY Committee (CSAGI) to the effect that, unless the Nationalists were dropped by CSAGI, the Chinese Communists would withdraw from the IGY entirely. After many futile attempts to retain both Nationalist China and Communist China as participants in the IGY, Communist China withdrew and was officially removed by CSAGI in February 1958. Nevertheless, there is every reason to believe that the Chinese Communists went ahead and conducted their planned geophysical observations unofficially, and probably in accordance with IGY standards. The Soviets probably sent the Chinese Communists copies of all the IGY data from their World Data Center "B" in Moscow. The Chinese Communists could thus obtain all of the benefits without having to make the data from their large and strategically located country available to the West. In order to exploit to the fullest this potential advantage over the West, Communist China, with additional technical support from the Soviet bloc, may have broadened the scope of its geophysical observations. While the Chinese Communists were still planning to participate in the IGY, they were preparing to conduct seismological studies at from 7 to 10 stations, and geomagnetic observations at four stations. Plans for geoelectric and gravimetric observations were also announced, but details were never revealed. Fragmentary information indicates that the unofficial IGY data collected by the Chinese Communists are being sent to the Moscow data center; however, data have not been made available to the West.

(1) *Seismology* — Chinese Communist research in seismology, which emphasizes studies on the propagation of seismic waves, the processing and analysis of seismological observations, the interpretation of non-instrument seismological data, and microseismic research, is centered at the Institute of Geophysics and Meteorology (*Ti-ch'iu Wu-li Yen-chiu-so*) in Peiping. These studies concentrate on several broad programs which have important military and economic implications, including: 1) seismic regionalization, and antiseismic construction studies; 2) nuclear explosion detection; 3) storm tracking by microseismic research; and 4) mineral prospecting applications. Of the geophysical methods presently used for mineral prospecting in Communist China, seismological prospecting techniques are probably among the most important. Figure 76–13 describes activity underway at seismological stations in Communist China.

Seismic regionalization, or seismic zoning, studies attempt to determine adequately the time of earthquake occurrence and to delineate the

Figure 76–13. CHINESE COMMUNIST SEISMOLOGICAL STATIONS

Index No. Fig. 76–12	Name of Station (Variant)	City and Province Latitude, Longitude Elevation (in meters)	Seismological Equipment	Remarks
1	Harbin* (Ha-erh-pin)	Harbin, Heilungkiang 45°45'N., 126°39'E.	Probably equipped with a single type of 3-component Chinese-made Kirnos or Kharin seismograph with a recording galvanometer. May also have mechanically registering seismographs that are important for recording large earthquakes.	
2	Ch'ang-ch'un (Hsinking)	Ch'ang-ch'un, Kirin 43°52'N., 125°21'E. 216.	Large- and small-model sets of horizontal seismographs with mechanical registration and sets of horizontal seismographs with direct optical registration.	Proposed** IGY station. May be associated with Ch'ang-ch'un Geological Prospecting College.
3	Pao-t'ou	Pao-t'ou, Inner Mongolian Autonomous Region. 40°36'N., 110°03'E.	Probably equipped with a single type of 3-component Chinese-made Kirnos or Kharin seismograph with a recording galvanometer. May also have mechanically registering seismographs that are important for recording large earthquakes.	

See footnotes at end of table.

FIGURE 76–13 (*Continued*)

INDEX NO. FIG. 76–12	NAME OF STATION (VARIANT)	CITY AND PROVINCE LATITUDE, LONGITUDE ELEVATION (IN METERS)	SEISMOLOGICAL EQUIPMENT	REMARKS
4	Chiu-ch'uan* (Kiuchuan)	Chiu-ch'uan, Kansu 39°46′N., 98°34′E.	Probably equipped with a single type of 3-component Chinese-made Kirnos or Kharin seismograph with a recording galvanometer. May also have mechanically registering seismographs that are important for recording large earthquakes.	
5	Ta-t'ung*	Ta-t'ung, Shansi 40°08′N., 113°13′E.	Probably equipped with a single type of 3-component Chinese-made Kirnos or Kharin seismograph with a recording galvanometer. May also have mechanically registering seismographs that are important for recording large earthquakes.	
6	Hsüan-hua* (Suanhwa)	Hsuan-hua, Hopeh 40°38′N., 115°06′E.	Probably equipped with a single type of 3-component Chinese-made Kirnos or Kharin seismograph with a recording galvanometer. May also have mechanically registering seismographs that are important for recording large earthquakes.	
7	Peiping (Peking)	Peiping, Pei-ching Shih 39°56′N., 116°24′E. 43.	Kirnos-type seismograph for registering distant and local earthquakes; Kharin-type seismograph for registering weak local tremors; Galitzin-Wilip seismographs for registering distant earthquakes.	Proposed** IGY station. First established about 25 miles west of Peiping. Registration began September 1930, and bulletins were published. Destroyed in July 1937; restored in August 1943. Large building and underground vault built in 1957. Employs five men.
8	Dairen* (Ta-lien)	Dairen, Liaoning 38°55′N., 121°39′E.	Probably equipped with a single type of 3-component Chinese-made Kirnos or Kharin seismograph with a recording galvanometer. May also have mechanically registering seismographs that are important for recording large earthquakes.	
9	Yin-ch'uan	Yin-ch'uan, Ningsia Hui Autonomous Region. 38°28′N., 106°19′E.	Probably equipped with a single type of 3-component Chinese-made Kirnos or Kharin seismograph with a recording galvanometer. May also have mechanically registering seismographs that are important for recording large earthquakes.	

See footnotes at end of table.

FIGURE 76–13 (*Continued*)

INDEX NO. FIG. 76–12	NAME OF STATION (VARIANT)	CITY AND PROVINCE LATITUDE, LONGITUDE ELEVATION (IN METERS)	SEISMOLOGICAL EQUIPMENT	REMARKS
10	T'ai-yüan*	T'ai-yüan, Shansi 37°52'N., 112°33'E.	Probably equipped with a single type of 3-component Chinese-made Kirnos or Kharin seismograph with a recording galvanometer. May also have mechanically registering seismographs that are important for recording large earthquakes.	
11	Wu-wei*	Wu-wei, Kansu 37°58'N., 102°48'E.	Probably equipped with a single type of 3-component Chinese-made Kirnos or Kharin seismograph with a recording galvanometer. May also have mechanically registering seismographs that are important for recording large earthquakes.	
12	Hsi-ning*	Hsi-ning, Tsinghai 36°37'N., 101°46'E.	Probably equipped with a single type of 3-component Chinese-made Kirnos or Kharin seismograph with a recording galvanometer. May also have mechanically registering seismographs that are important for recording large earthquakes.	
13	Lan-chou	Lan-chou, Kansu 36°03'N., 103°41'E. 1,506.	1951-type Kirnos and Kharin seismographs for near and distant earthquakes. Strong tremors recorded on two complexes of Model-51 horizontal seismographs (designed in 1951 by Li Shan-pang). Kharin instrument usable at maximum magnifications without recording parasitic oscillations. Underground vault.	Proposed** IGY station, 6 to 9 miles from town in loess country. Affiliated with CPR Academy of Sciences. Recorded intensity 4 quakes in February 1954. Staff of five. Director, Chin Chan-hsing.
14	Lin-fen*	Lin-fen, Shansi 36°05'N., 111°32'E.	Probably equipped with a single type of 3-component Chinese-made Kirnos or Kharin seismograph with a recording galvanometer. May also have mechanically registering seismographs that are important for recording large earthquakes.	
15	Tsingtao (Ch'ing-tao)	Tsingtao, Shantung 36°04'N., 120°19'E. 77.	Two horizontal Weichert seismographs installed in 1926, and a Galitzin seismograph.	Opened by Germans in 1898, occupied by Japanese during World War I; passed to Chinese control in 1924. Under Japanese from 1936 until return to Chinese control in 1946.
16	Sian (Hsi-an) (Siking)	Sian, Shensi 34°16'N., 108°54'E. 395.	Large- and small-model sets of horizontal seismographs with mechanical registration. Also sets of Model-51 horizontal seismographs with direct optical registration. Three Chinese Kirnos seismographs.	Station housed in special building with heat insulated laboratories. Proposed** IGY station. Part of Northwest University. One-man station. No underground vault.

See footnotes at end of table.

FIGURE 76–13 (*Continued*)

INDEX NO. FIG. 76–12	NAME OF STATION (VARIANT)	CITY AND PROVINCE LATITUDE, LONGITUDE ELEVATION (IN METERS)	SEISMOLOGICAL EQUIPMENT	REMARKS
17	T'ien-shui*	T'ien-shui, Kansu 34°35′N., 105°33′E.	Probably equipped with a single type of 3-component Chinese-made Kirnos or Kharin seismograph with a recording galvanometer. May also have mechanically registering seismographs that are important for recording large earthquakes.	
18	Nanking (Nan-ching)	Nanking, Kiangsu 32°03′N., 118°47′E. 68.	Latest model Soviet seismographs for registration of ordinary earthquakes. Also Galitzin-Wilip vertical and horizontal seismographs. Weichert horizontal seismograph (mass, 17 tons), Weichert vertical seismograph (mass, 1,300 kilograms), sets of horizontal seismographs Model–51 with mechanical registration.	Proposed** IGY station. With short interruptions the station has been operating since 1931. Now housed in a special building in eastern part of Nanking near other academic institutes at foot of picturesque Pe-chi-ko Hill. Station also known as Pe-chi-ko Observatory.
19	Liu-an*	Liu-an, Anhwei 31°45′N., 116°30′E.	Probably equipped with a single type of 3-component Chinese-made Kirnos or Kharin seismograph with a recording galvanometer. May also have mechanically registering seismographs that are important for recording large earthquakes.	
20	She Shan (Zose) 31°06′N., 121°11′E.	Near Shanghai, Shang-hai Shih. 31°14′N., 121°28′E. 100.	Galitzin, vertical seismograph, two Galitzin-Wilip horizontal seismographs, Weichert horizontal seismograph (mass, 1,200 kilograms), two horizontal seismographs with direct optical registration, sets of Model–51 horizontal seismographs with mechanical registration and microseismic equipment with three Kirnos vertical seismographs.	Proposed** IGY station. In 1951 Soviet technicians whose purpose and work are unknown may have been working at the seismographic station. Tripartite microseismic station proposed for IGY. Located 25 miles from town on volcanic rock in damp basement. High humidity interferes with microseismic research.
21	Ch'eng-tu	Ch'eng-tu, Szechwan 30°40′N., 104°04′E. 498.	Set of latest model Soviet seismographic equipment capable of registering local as well as distant earthquakes throughout the world.	A new seismological station was recently established in a suburb southwest of Ch'eng-tu.
22	Wu-han*	Wu-han, Hupeh 30°34′N., 114°13′E.	Probably equipped with a single type of 3-component Chinese-made Kirnos or Kharin seismograph with a recording galvanometer. May also have mechanically registering seismographs that are important for recording large earthquakes.	
23	Lhasa	Lhasa, Tibet 29°39′N., 91°06′E. 3,630.	Model–51 horizontal seismograph designed and produced in China. Copy of Soviet Kirnos seismographs also built in China.	Proposed** IGY station. Sponsored by Institute of Geophysics, CPR Academy of Sciences. Began operation 31 January 1957.

See footnotes at end of table.

FIGURE 76–13 (*Continued*)

INDEX NO. FIG. 76–12	NAME OF STATION (VARIANT)	CITY AND PROVINCE LATITUDE, LONGITUDE ELEVATION (IN METERS)	SEISMOLOGICAL EQUIPMENT	REMARKS
24	K'un-ming.............	K'un-ming, Yunnan...... 25°04'N., 102°41'E. 1,922.	Latest model Soviet seismographs for registration of ordinary earthquakes.	Proposed** IGY station.
25	Canton................. (Kuang-chou)	Canton, Kwangtung...... 23°07'N., 113°15'E. 9.	Two sets of Model–51 horizontal seismographs with mechanical registration and one complete set of SGK and SVK (horizontal and vertical Kirnos) Soviet-type seismographs. Three SVK–2 seismographs arranged in triangular system to detect microseisms.	Proposed** IGY station. Located on a naval base but may be operated by the Academy of Sciences, along with a geomagnetic station.
26	Hsü-chia-hui............ (Zi-ka-wei) 31°11'N., 121°25'E.	Shanghai, Shang-hai Shih 31°14'N., 121°28'E. 7.	Old horizontal 20-kilogram Japanese Omori installed in 1903. Old horizontal 1,200-kilogram Weichert in 1909. Galitzin recorder with electrical registration in 1913. Vertical 80-kilogram Weichert seismograph in 1923.	Published bulletins as early as 1903. Organized in Shanghai suburb in 1904. Taken over by Communists in 1950. Operated with some interruptions until around 1956. Since then, moved about 25 miles south to Zo-se.
27	Chungking............ (Ch'ung-ch'ing).......	Chungking, Szechwan..... 29°34'N., 106°35'E. 291.	....	Established during World War II, but may have been abandoned before proposed IGY reactivation.

* Name of station uncertain; named for the most prominent nearby city. Latitude and longtitude shown are approximate.

** Not actually included in official program of Special Committee for the International Geophysical Year (CSAGI) because of removal of Chinese Communists from the program.

areas that have been subjected to earthquakes in the past, in order to predict the probable intensity and frequency of future earthquakes. Such information is of great importance to architects and builders who must design and construct large factories, dams, or bridges in seismic areas.

A group of Chinese Communist seismicity specialists has adopted Soviet techniques to prepare a seismological map of China that delineates the regions in which earthquakes of various intensities are expected. A preliminary study, under the direction of Li Shan-pang, was completed in 1957, which combined all available instrument and non-instrument seismological data on earthquake occurrences in China for some 22 centuries. To increase the accuracy of the seismological map, with a more detailed analysis of the tectonic processes of earthquakes, is the main purpose of the seismicity group at the Institute of Geophysics and Meteorology.

An engineering seismology group at the institute, recently formed under the direction of Hsieh Yu-shou, is investigating the results of several destructive earthquakes. This group works with the Institute of Mechanics (*Li-hsueh Yen-chiu-so*), Peiping, and the Institute of Civil and Architectural Engineering (*T'u-mu Chien-chu Yen-chiu-so*), AS.

In 1956, the spacing of the nation's seimological network was considered inadequate, not only by the Chinese Communists themselves, but also by a visiting delegation of Soviet seismologists. The establishment of at least 18 new stations has begun in order to improve both earthquake recording and explosion detection. Additional research is to emphasize seismic waves propagation, the mechanism of earthquake centers, the energy of earthquakes, the determination of forerunners of earthquakes, and engineering seismology.

Among the IGY studies originally planned by the Chinese Communists was microseismic research for tracking storms that were still far out at sea. Well-equipped tripartite stations, consisting of three separately instrumented and interconnected stations located a few hundred feet apart, observe and record the small microseismic oscillations that are believed to be associated with storms at sea. Inconclusive results in Western microseismic research have made this work appear to be of dubious value.

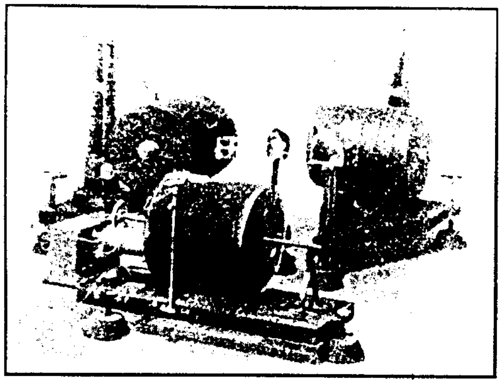

FIGURE 76–14. HORIZONTAL SEISMOGRAPHS DEVELOPED IN COMMUNIST CHINA

In early 1958, the Chinese Communist seismological network consisted of some 25 stations or observatories. The stations are instrumented by a variety of seismographic apparatus, including Li Shan-pang's Model-51 seismograph, patterned after the Soviet Kirnos seismograph. Soviet and Western seismological instruments are also used at a number of the stations. FIGURE 76–14 shows a horizontal seismograph developed in Communist China.

(2) *Geodesy* — During 1953–54, determinations were made of the initial points, and a system of uniform geodetic coordinates and elevations had been established. This system of geodetic coordinates has been named the "Peiping system of coordinates, 1954," and the system of elevations was based on the level of the Yellow Sea. The establishment of these systems has been significant in the development of geodesy and cartography in China.

Between 1953 and 1957, the nation's geodesists constructed many state control points and ran high-precision leveling traverses. By the end of 1957, approximately half of the country was well-provided with a modern high precision series of first-order triangulation and high precision leveling. This made it possible to expand a unified system of coordinates and elevations over the entire populous part of mainland China, and thereby created favorable conditions for setting up surveys of extensive areas. A considerable part of the country had been covered by 1957, with new state topographic surveys at a scale of 1:50,000 and 1:100,000. Large areas were surveyed which were scheduled for the development of: 1) hydrologic and irrigation installations; 2) large industrial plants and railroad construction; 3) agriculture; and 4) the utilization of new land areas.

At present, general geodetic, topographic, and cartographic operations are performed by subdivisions of the State Bureau of Surveying and Cartography. The topographic and geodetic organizations of other ministries and departments carry out other surveys. The bureau renders considerable assistance to these organizations in preparing aerial photographic sketches and plans; by providing initial data on triangulation and leveling; in holding periodic meetings of key employees of the departmental organizations to consider the more important problems of planning, organization, methods and techniques of carrying out topographic and geodetic operations; and in providing instructions and directions to improve geodetic surveying throughout the country.

Chinese geodesists have made extensive use of Soviet experience in developing their geodetic instructions, directions, and conventional signs. The publication and introduction of these documents into practice are expected to contribute to an increase in the quality of geodetic and topographic work in Communist China.

In consideration of the requirements for a modern topographic map of Communist China, the geodetic service has developed a prospective plan which calls for the completion of first-order triangulation in 1961, and for compilation of a topographic map of the entire country by 1967. Three different scales are contemplated: 1) areas important from the standpoint of the national economy are to be surveyed on a scale of 1:25,000; 2) the rest of the densely populated and economically developed areas, on a scale of 1:50,000; and 3) the desert, mountainous and high altitude areas, on a scale of 1:100,000. After 1967, maps will be plotted in greater detail.

Especially significant is the development of methods of map plotting in the high-altitude areas of the country. Considerable effort has been made to introduce methods of reducing the amount of field work, in order to reduce the time it will take to map these areas at 1:100,000. Radiogeodetic, or electronic range finder, equipment has been considered along with other new instruments. Investigations are also being conducted in geodetic gravimetry, practical astronomy, the methods of adjustment of the astronomic and geodetic networks by means of photogrammetry, stereophotogrammetry, and cartography. Several research establishments of the AS are cooperating in this work.

A series of articles in the geodesy and cartography journal published in Peiping described an astronomical and geodetic survey exhibition containing exhibits relating to baseline measurements, leveling, astronomical surveys, gravity measurements, and geodetic computations. Other exhibits include those on hydrographic surveys, aerial photogrammetry, map compilation, map printing, and domestic instruments. The practical uses of surveying and cartographic work were also shown in exhibits on its applications in: railroad construction, water conservancy project construction, forestry, geology, urban construction, agricultural reclamation, maps for education and maps for general use.

(3) *Gravimetry** — The gravimetric survey network over Communist China has been improved qualitatively and increased quantitatively during the past several years. This improvement has come chiefly as the result of increased emphasis on geodetic surveys. Nevertheless, the Chinese capability in such a complex and far-reaching science has been, and still is, relatively low. However, the broad aid program provided by the Soviet Union in these sciences has brought about a significant increase in the Chinese Communist gravimetric capability. The Soviets have sent trained technicians and gravity instruments to the Chinese Communists; have trained personnel; and have conducted gravity surveys with, and for, them. Whether this really was a Soviet aid program to help the Chinese or just another convenient method of obtaining large quantities of foreign gravimetric data, is uncertain.

Most of the gravimeters in Communist China are of foreign manufacture. Although the Chinese Communists are reported to have had some success in building Soviet-type gravimeters, the general complexity of gravity meters is such that these Chinese instruments are probably not as accurate as those imported from the Soviet bloc countries or western Europe. There is no evidence to show that the Chinese Communists either have or are making any effort to develop gravimeters for use at sea or in the air.

Gravimetric surveys for prospecting purposes in mainland China have employed both gravimeters and the more cumbersome torsion balance equipment, which reflects the probable influence of Hungarian geophysics. Indeed several teams of Hungarian geophysicists and exploration teams, some with 30 or more geophysicists, have worked in Communist China under contract for periods of from one to two and one-half years. These teams came both to teach the Chinese how to use their new exploration equipment and to help conduct oil prospecting activities in the Gobi Desert and other parts of the country. East Germany, Rumania, Czechoslovakia, and Poland have also provided geophysical prospecting aid on a much smaller scale.

(4) *Geomagnetism and geoelectricity* — The chief use of geomagnetic research in Communist China is for mineral prospecting surveys. Military uses of geomagnetism for detection purposes have been reported but not confirmed. Military and civil use of geomagnetism for navigational purposes is another important application of the science. Basic research on magnetic storms and routine geomagnetic observations are being conducted, as are attempts to develop applications of geomagnetism and geoelectricity, or earth currents, as an aid to communications. Communist China has 10 geomagnetic observatories located at Ch'ang-ch'un, Peiping, Lan-chou, Tsingtao, Nanking, She Shan (Zose), Wu-han, Lhasa, K'un-ming, and Canton. Figure 76–15 describes facilities at these locations.

Specialized studies on the prediction of magnetic storms were planned for the observatories at She Shan (Zose) and K'un-ming during the IGY, and are probably still being conducted. The K'un-ming Observatory (*K'un-ming T'ien-wen-t'ai*) was very small and may not yet have all of its planned equipment. Although the Chinese Communists have developed a few of their own specialized geomagnetic instruments for laboratory research, most of their observatory and magnetic prospecting instruments have been imported from the U.S.S.R. and the East European bloc countries.

The Chinese Communists planned to have four IGY geomagnetic observatories in operation at the beginning of the IGY, and they expected to add two or three more later, depending on the availability of instruments.

Geoelectric, or earth current, studies are conducted at a station in Peiping. In January 1956, the Peiping Observatory of the Institute of Geophysics and Meteorology, AS, cooperated with a similar station in Sopron, Hungary, in making simultaneous measurements of telluric (geoelectric) currents over a 6-day period. The purpose of the experiment was to compare the changes in relative frequency with the fluctuation in the total change vector to see whether the decrease or increase in the fluctuation is related to the frequency or to the amplitude change.

During the IGY, the Chinese Communists planned to install geoelectric equipment at a station in Lhasa to record the change in earth currents between there and Peiping. Western scientists have noted the level of interest in earth

* Gravimetry, or physical geodesy as it is sometimes called, consists of surveys used to make computations of deflections of the vertical, which are used in correcting geodetic triangulation surveys. One of the most important applications of gravimetry is in support of geodesy and cartography.

FIGURE 76-15. CHINESE COMMUNIST GEOMAGNETIC OBSERVATORIES

INDEX NO. FIG. 76-12	NAME OF STATION (VARIANT)	CITY AND PROVINCE LATITUDE, LONGITUDE ELEVATION (IN METERS)	REMARKS
2	Ch'ang-ch'un (Hsinking)	Ch'ang-ch'un, Kirin 43°52'N., 125°21'E. 216.	
7	Peiping (Peking)	Peiping, Pei-ching Shih 39°56'N., 116°24'E. 43.	Central geophysical observatory, located 20 miles west of the center of Peiping. Has 3 nonmagnetic buildings that were opened in 1955. Earth current measurements were planned during IGY. Bamberg standard magnetic theodolite and Schuster-Smith coil magnetometer. Ordinary and rapid run LaCour magnetographs.
13	Lan-chou	Lan-chou, Kansu 36°03'N., 103°41'E. 1,506.	Lan-chou Geophysical Observatory built for the IGY in the hills outside the city. Temporary set of Askania instruments in geomagnetic research building.
15	Tsingtao (Ch'ing-tao)	Tsingtao, Shantung 36°04'N., 120°19'E.	In operation from 1916–1936. May have been reactivated in June 1947.
18	Nanking (Nan-ching)	Nanking, Kiangsu 32°03'N., 118°47'E. 68.	Nanking (Purple Mountain) Geomagnetic Observatory conducts research on magnetic storm forecasting; also makes sunspot observations.
20	She Shan (Zose) 31°06'N., 121°11'E.	Near Shanghai, Shang-hai Shih. 31°14'N., 121°28'E. 110.	She Shan Astronomical Observatory. Conducts research on magnetic storm forecasting; also makes sunspot observations. Magnetic observations formerly conducted at Zi-ka-wei and Lu-kia-pang. Bamberg standard magnetic theodolite and Schuster-Smith coil magnetometer. Ordinary and rapid-run LaCour magnetographs. Soviet-designed fluxmeter to measure changes in horizontal and vertical intensity.
22	Wu-han	Wu-han, Hupeh 30°34'N., 114°13'E. 28.	Probably in planning stage.
23	Lhasa	Lhasa, Tibet 29°39'N., 91°06'E. 3,630.	Planned earth-current measurements during the IGY. Bamberg standard magnetic theodolite and Schuster-Smith coil magnetometer. Reportedly Chinese-made LaCour ordinary and rapid-run magnetographs.
24	K'un-ming	K'un-ming, Yünnan 25°04'N., 102°41'E. 1,922.	Feng Huang Shan Observatory. Plans or conducts research on magnetic storm forecasting; also makes sunspot observations.
25	Canton (Kuang-chou)	Canton, Kwangtung 23°07'N., 113°15'E. 9.	Bamberg standard magnetic theodolite and Schuster-Smith coil magnetometer. Ordinary and rapid-run LaCour magnetographs. Soviet-designed fluxmeter to measure changes in horizontal and vertical intensity. Unusual care was used in building this station, which has both a recording room and a standards room.

current research in the Sino-Soviet bloc and have concluded that this work might have significance in the field of military communications.

The Chinese Communists are continuing to make airborne magnetometer surveys over their country for mineral exploration purposes. The systematic use of such surveys often provides data on magnetic anomalies that either indicate the presence of magnetic minerals themselves or underground rock structures that are favorable to the location of oil and other minerals.

c. SIGNIFICANT RESEARCH FACILITIES

Institute of Geodesy and Cartography (Ts'e-liang Chih-t'u Yen-chiu-so), Wu-ch'ang—Director: believed to be Fang Chun. This facility, subordinate to the Department of Earth Sciences, AS, was established in 1950 as the Geodetic Surveying Division of the Research Institute of Geography, AS. In August 1957, it was reorganized as the Geodesy and Cartography Research Office and, in January 1959, the organization achieved full institute status within the AS. Other names for this organization include the Laboratory of Geodetics and Cartography and the Institute of Survey and Cartography.

The institute, originally located in Nanking, moved to its present location in the spring of 1957. In 1958, it was reported to have seven scientific departments (applied astronomy, geodesy, gravimetry, electronic engineering, photogrammetry, cartography, and precision instrument techniques) and four service departments (scientific and technical document exchange, tools and instruments, library, and administration and supply). The establishment of an experimental precision optical instrument factory also has been reported.

The primary functions of the institute are to conduct research into all fields of geodesy and cartography and to compile and publish large-scale maps. During 1959, the institute was concentrating on the following projects: 1) research and development of new geodetic and cartographic instruments; 2) study of the topography of Communist China and development of the best methods for carrying out geodetic surveys in remote areas, particularly in Tsinghai and Tibet; 3) the study of methods and theories for the rapid compilation of large-scale maps; and 4) cooperation with the State Bureau of Surveying Cartography in studying problems of electronic surveying, in making gravity measurements throughout the country, and in the establishment of a permanent gravity observation station at Wu-ch'ang.

The institute has established basic astronomic points at Sian, Ch'eng-tu, Urumchi, Wu-han, Canton, and the Zikawei Observatory. Early in 1959, the institute was reported to have developed an aerial radar survey instrument which is believed to be similar to a Shoran surveying apparatus; a small gravimeter based on a Swedish gravimeter, but smaller in size; time determination, recording, broadcasting, and monitoring equipment; an altimeter; and an attachment for the T4 theodolite which will record fourth and fifth magnitude stars and is practical for field use. In April 1959, the institute had about 265 personnel; about one-fourth of these were scientists.

Institute of Geophysics and Meteorology (Ti-ch'iu Wu-li Yen-chiu-so), Peiping—Director: Chao Chiu-chang. This institute, subordinate to the Department of Earth Sciences, AS, operates between 25 and 30 seismological stations and about 10 geomagnetic observatories located around the country. The combined geomagnetic and seismological observatory at Canton was probably established as a combined detection facility for foreign nuclear test explosions in the western Pacific.

d. OUTSTANDING PERSONALITIES

CHANG Hung-chi, Dr.—Gravimetry. Vice president, Peiping Geological Institute, Ministry of Geology, in 1957. Received his education in China at Chiaotung University, and in the United States at Louisiana State University. Has written, in collaboration with Father Pierre Lejay, a number of articles dealing with the measurement of gravity in China prior to World War II.

CH'EN Tsung-ch'i (CHEN, Parker C.) (7115/1350/0892)—Geogmagnetism. Internationally known geogmagnetologist. Deputy director, Institute of Geophysics and Meteorology, AS, since 1950. Secretary, Chinese National Committee for the IGY and head of Working Group on Geomagnetism. Very active at IGY conferences in Moscow and Barcelona in 1956. Assistant research fellow, Institute of Physics, Chinese Academy of Sciences, 1930's and 1940's. During 1950 he was associate editor of the *Journal of the Chinese Geophysical Society*. Knowledgeable of geophysics of Sinkiang Province. Studied in Germany at Göttingen University under Professor Julius Bartel. Author of "Preliminary Report of the Results of the Geomagnetic Survey of China, 1946–47," and co-author of "The Geomagnetic Condition of Southeastern China." Born: 1899.

CHOU Ch'ia (CHOW, Carl), Eng.—Geodesy, aerial photography, and mathematics. Considered a skillful technician but not a good scientist. On the staff of the Peiping Geological Institute, since 1956, and of the Engineering College, Peiping University, 1951–56. Employee, Research and Analysis Division, U.S. Army Map Service, January 1948 to October 1949. Geodesy instructor, Central Land Surveying College, 1940–43. Geodetic engineer, Chinese Nationalist Government, 1940–45. Studied at Cornell and Syracuse Universities. Research has concerned aerial triangulation and measuring mineral resources by aerial photography. Born: 1915.

CHU Kang-k'un—Geomagnetism and meteorology. Prominent geomagnetologist. On the staff, Institute of Geophysics and Meteorology, AS, 1950–57. Assistant secretary, Chinese National Committee, IGY, 1956. Staff, Institute of Physics, AS, 1948. Staff, Institute of Geophysics and Meteorology, AS, 1947. Student in England at Oxford University under Professor Sydney Chapman, probably between 1946–53. Authority on China's geomagnetic observatories.

CHU K'o-chen (CHU, Coching) (4555/0668/1506), Dr.—Geodesy and meteorology. Regarded primarily as a scientific administrator. Vice president, AS. Received his training in the United States. Director, Institute of Geophysics and Meteorology, *Academia Sinica,* from 1928–1935. Appointed president, Chekiang University, March 1936. Lecturer in geodesy and meteorology, National Southeastern University during 1920–25. Editor, Commercial Press, Shanghai, and author of numerous meteorological articles. Chairman, Geodesy Department, National Central University, 1927. Has attended numerous professional meetings and international conferences. Born: 1890.

FU Ch'eng-i (FU, C. Y.), Dr.—Seismology. Outstanding teaching and research seismologist. Member, Department of Earth Sciences, AS, 1957. Served on staff of Geophysical Section, Department of Physics, Peiping University, 1955–56. Staff, Institute of Geophysics and Meteorology, AS, 1950–57 (probably director of Peiping Seismological Station). Chairman, editorial board of *Geophysics Journal*, 1954. Part-time assistant professor of geophysics, California Institute of Technology, 1946–47, and has held other geophysical positions in the United States, 1942–46. Studied in the

United States at California Institute of Technology, where he received a Ph.D. degree in geophysics in 1944 under Professor Beno Gutenberg. Suspected of pro-Communist inclination while in the United States. Born: 1909.

KU Kung-hsü (KU, K. G.) (7357/0501/0650)—Geophysical prospecting and seismology. Specialties include geoelectricity and geomagnetism, field seismology, geological paleontology. Important U.S.-trained geophysicist. Director, Geological Exploration Office, Ministry of Geology, 1954–57. Deputy director, Institute of Geophysics and Meteorology, AS, about 1950–57. Member of the committee of the academy's Department of Biology and Earth Sciences. Director, Geophysical Exploration Office of the Ministry of Geology. Research assistant, Seismology Laboratory, California Institute of Technology, 1936–38. Studied at the Colorado School of Mines, 1936. Associate editor of the geophysical journal. Presumed to be thoroughly familiar with oil-producing regions of Western China. Recent papers: "General Prospecting Tasks for Petroleum and Geophysical Exploration Work" and "A New Trend in Geophysical Prospecting for Subterranean Resources with All-Out Emulation of the U.S.S.R." Born: 1907.

LI Shan-pang (Lee, S. P.)—Seismology. Considered the leading seismologist in Communist China. Head, Department of Seismology, Institute of Geophysics and Meteorology, AS, since 1957; staff member, since 1952. Established first seismological station in China, 1930. Head, Working Group on Seismology, Chinese National Committee for the IGY, 1957. Director of Geophysics Section, National Geological Survey 1943–47. Research fellow at the Institute of Geology of the National Academy, Peiping. Studied at Seismological Laboratory, California Institute of Technology, under Professor Beno Gutenberg, 1935. Has been a member of American Seismological Society, Chinese Geological Society, and Nationalist Academy of Sciences. Participated in Gravity and Seismology Working Groups in the IGY Western Pacific Regional Conference in Tokyo, 1957. Associate editor of the *Journal of the Chinese Geophysical Society*. Developed Chinese version of Soviet Kirnos seismograph in 1951. Author: "Earthquake Intensity"; "Deep-Focus Earthquakes in Central Asia." In late 1957, was engaged in a survey of the seismicity of Communist China. Born: 1902.

5. Physics

a. GENERAL

(1) *Capabilities and trends* — Physics in China is in the beginning stages. There are only a few scientists who rank with leading physicists in the West. They comprise a small, and quite inadequate, core of leading research workers and teachers—almost all of whom were educated in the West, primarily in the United States. The facilities for basic research in physics in China are extremely limited but are gradually being expanded. For example, in the past few years a cosmic ray station was constructed and equipped and a research reactor and a 25-Mev. cyclotron (both of Soviet origin) were installed. In addition, the Chinese completed their first large high-speed digital computer early in 1959.

Theoretical and experimental nuclear physics are being particularly emphasized in China. The theoretical nuclear physics work is competent and indicates that the theorists are well aware of Western developments. No significant experimental nuclear physics research has as yet been conducted in China, since the necessary equipment has only recently been installed. The Chinese are also emphasizing development of computers, but their original work in this area is quite limited. A less intense but, nevertheless important, effort is being concentrated on infrared physics, optics, spectroscopy, plasma physics, and solid state physics. In each of these areas the major concern is in practical applications rather than original research. The Chinese are also conducting some research in cosmic ray physics, upper atmosphere physics, and acoustics.

At present, Chinese physics is capable of contributing to both the military and economic potential of the country, but only to a limited extent. The construction and operation of computers is possibly of the greatest importance, but some assistance is also available from the various devices developed through research in acoustics, infrared, optics, plasma physics, and solid state physics.

Chinese scientists have, during 1958–60, attended and participated in, to a limited extent, international conferences on acoustics, high energy nuclear physics, and cosmic ray physics. The Chinese have been aided by the U.S.S.R. in obtaining equipment and training specialists, particularly in the fields of computers, nuclear physics, and solid state physics.

(2) *Background and organization* — The Communist regime, recognizing the importance of basic and applied physics to the technological and military advancement of the country, is intensively promoting its development. Physics research is to a large extent under the control and planning of the Chinese Academy of Sciences (*Chung-kuo K'o-hsueh-yuan*), AS, Peiping, which is, in turn, subordinate to the (State) Scientific and Technological Commission (*K'o-hsueh Chi-shu Wei-yuan-hui*), responsible for coordinating all scientific effort in China.

Certain areas of physics are controlled to some extent by organizations in addition to the academy. For example, research in optics is coordinated with the optical industry which is subordinate to the First Ministry of the Machine Building Industry (*Ti-i Chi-hsieh Kung-yeh Pu*). Computer development and the training of specialists in this field are carried out, not only within the academy, but also within organizations of the Ministry of Education (*Chiao-yu Pu*), various industrial ministries, and probably some military ministries.

The Chinese Physical Society (*Chung-kuo Wu-li Hsueh-hui*), which was founded in 1932 and later reorganized, influences somewhat the direction of physics research. In 1956, the society held a semiconductor conference, at which time the members suggested that a separate Institute of Semiconductors be organized within the AS; however, this institute is not known to have been established as a separate facility within the academy. Rather, it is believed that this organization is still an important part of the Institute of Physics, AS. During the few years that the Chinese Twelve Year Plan for Science has been in operation, there have been advances in physics. For example, it was not until about 1956 that a Chinese optical industry came into operation and, even more recently, that success was attained in the production of high precision optical instruments. Chinese capability for computer development began to attain importance about 1956 with the establishment of the Institute of Computation Techniques (*Chi-suan Ch'i-shu Yen-chiu-so*), Peiping, following in 1957. Similar signs of progress became apparent about this time in other fields of physics, notably nuclear physics, cosmic ray physics, and infrared physics. Although progress is being made in physics research in China, much work needs to be done before China can attain a strong capability in this field.

b. MAJOR RESEARCH AND DEVELOPMENT BY FIELD

(1) *Acoustics* — Basic research in acoustics in China is almost negligible. What little work is being done is directed toward practical applications of acoustics, particularly in ultrasonics, electroacoustics, and architectural acoustics. The Chinese have produced ultrasonic equipment, such as defect detectors and geological prospecting instruments. They have begun work on the standardization of noise codes in industry. "The First Conference on Ultrasonics" was held in Wuhan in 1959 to stimulate work in this field in China.

(2) *Computers* — For information on this subject, see SECTION 71 of this NIS.

(3) *Cosmic ray physics* — Only minor research has been conducted in cosmic ray physics in China. The facilities are meager and the total number of cosmic ray physicists in China is quite small, approximately twenty. Cosmic ray research in China is conducted primarily at the Institute of Atomic Energy (*Yuan-tzu-neng Yen-chiu-so*), IAE, of the AS in Peiping and at the institute's Lo-hsueh High Mountain Laboratory (*Lo-hsueh Kao-shan Shih-yen-shih*), also known as the Lo-hsueh Shan Cosmic Ray Observatory, Lo-hsueh, in Yünnan province. FIGURE 76–16 shows a laboratory unit within this observatory.

FIGURE 76–16. LABORATORY UNIT AT THE LO-HSUEH HIGH MOUNTAIN LABORATORY, 1957

The Chinese cosmic ray research program is suffering from an insufficient number of well-qualified scientists, insufficient numbers of young scientists pursuing this work, and inadequate financial resources to provide the necessary equipment, most of which must be imported. In spite of all these handicaps, Chinese scientists have published a few papers in Chinese journals on experimental cosmic ray research. One area of cosmic ray physics with which the Chinese have claimed to have had some success is in the production, on a small scale, of very good nuclear emulsions. This work reportedly has been done at the IAE.

A small group of Chinese cosmic ray physicists attended, but did not participate in the International Conference on Cosmic Rays, held in Moscow in July 1959. Their attendance may indicate that the Chinese are planning to increase their emphasis on this kind of research.

(4) *Infrared* — There is evidence that research and development in a variety of fields directly associated with infrared technology are now being conducted in China; however, much of this activity has been in existence only for a very few years. Various aspects of solid state physics associated with infrared, such as luminescence and semiconductors, are being actively investigated, as are other related fields, such as optics, spectroscopy, and cryogenics. Specifically, an automatically recording infrared spectrometer is reported to be in "trial production" at the Institute of Optics and Precision Apparatus and Instruments (*Kuang-hsueh Ching-mi Chi-hsieh I-ch'i Yen-chiu-so*), AS, Ch'ang-ch'un; however, it is not known whether or not this is a copy of a Soviet copy of a U.S. spectrometer, or whether anything original has been incorporated.

In spite of a very recent start in infrared technology, the Chinese are probably developing capabilities in this field very rapidly with the help of the U.S.S.R. and other bloc countries. It is believed that the major development and use of infrared is probably confined, at the present time, almost exclusively to the field of absorption spectroscopy.

(5) *Nuclear physics* — Research in nuclear physics is improving gradually. There are no facilities in China for research in high energy nuclear physics and only meager facilities for low energy nuclear physics. As China is one of the twelve member nations of the Joint Institute for Nuclear Research (JINR), Dubna, U.S.S.R., Chinese physicists have been able to utilize the high energy accelerators at this facility. In 1959 and 1960, Wang Kan-ch'ang, an outstanding Chinese physicist, was among a group of scientists at JINR who claimed to have discovered two new fundamental particles. The discovery of the first of these particles, the existence of which had not been predicted by theory, has not been confirmed. Western physicists, however, have viewed Soviet photographs of the second particle, an anti-sigma-minus hyperon, and have authenticated the discovery. The Soviet (and Chinese) work in recording the tracks of the second particle is of great value to the progress of the study of high energy nuclear physics.

The facilities for low energy nuclear physics in China include a 25-Mev. cyclotron from the U.S.S.R (see FIGURE 76–17) and a few Van de Graaff accelerators (see FIGURES 76–18 and 76–19) of 2.5 Mev. range or less. A few other small accelerators are in the planning or construction stage. There are no indications that any research has been conducted to date with the cyclotron, although it was installed in 1958. FIGURE 76–20 shows a 5-Mev. inductance cyclotron designed and built at Tsinghua University, Peiping, 1958.

There is a small group of competent, Western trained, nuclear physicists to direct Chinese efforts in this area of physics as more facilities become available and as more young scientists become trained. An indication of the interest of Chinese physicists in high energy nuclear physics research is shown by their attendance at both the International Conference on High Energy Nuclear Physics in Kiev, U.S.S.R., in July 1959 and the International Conference on High Energy Accelerators and Instrumentation in Geneva, Switzerland, September 1959.

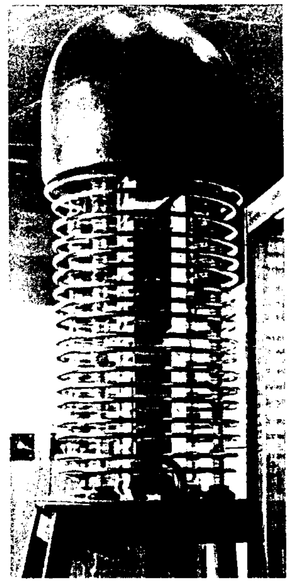

FIGURE 76–18. 25-MEV. VAN DE GRAAFF ACCELERATOR AT THE INSTITUTE OF PHYSICS, AS, PEIPING, 1957

(6) *Optics* — Although limited research and development in optics had been conducted in China prior to about 1956, it was not until the Chinese began to organize an optical and photographic industry about this time that research facilities were developed and expanded. Basic research in optics and development of scientific instruments are conducted under the auspices

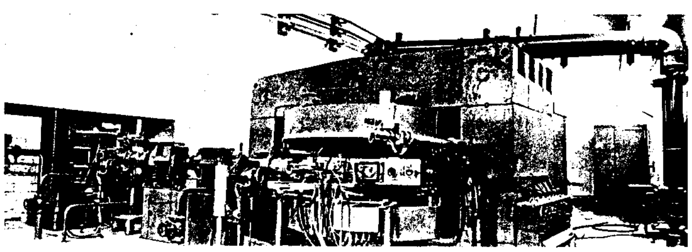

FIGURE 76–17. NEWLY COMPLETED 25-MEV. CYCLOTRON, BUILT WITH SOVIET HELP

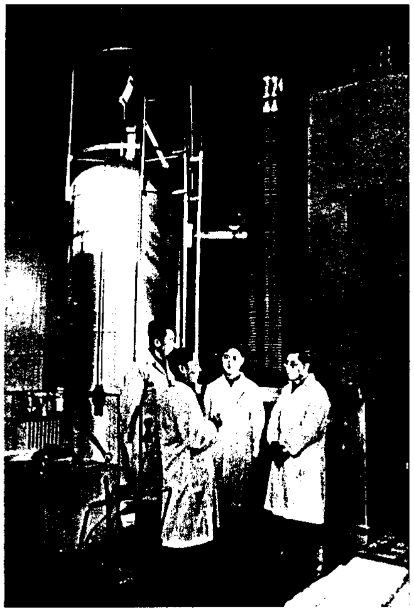

FIGURE 76–19. HIGH PRESSURE ELECTROSTATIC ACCELERATOR BUILT BY CHINESE SCIENTISTS

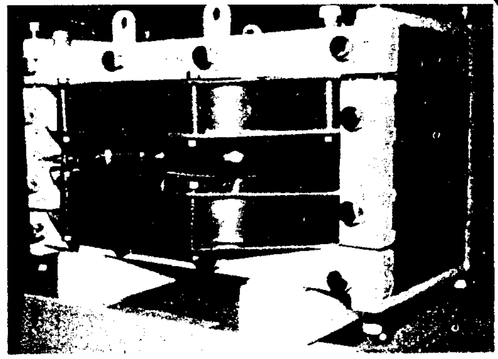

FIGURE 76–20. 5-MEV. INDUCTANCE CYCLOTRON DESIGNED AND BUILT AT TSINGHUA UNIVERSITY, PEIPING, 1958

of the AS, while research and development of optical devices for industrial use are conducted by the Optical Devices Office of the Shanghai Scientific and Industrial Instrument Research Institute (*Shang-hai I'ch'i I-piao K'o-hsueh Yen-chiu-so*), Shanghai. A limited amount of research and development is also conducted in some of the state-controlled optical plants.

The rapid expansion in China of industrial construction has probably stimulated the present demand for optical surveying instruments and related precision optical equipment. The production of such instruments, including numerous types of microscopes, as well as spectrographic equipment, requires the support of a well-developed high grade optical glass industry and associated research and development of related technologies. The analytical requirements of the expanding Chinese metallurgical industry undoubtedly have stimulated research and development of emission spectrographic equipment, the most rapid means of precision analysis of both ferrous and nonferrous metals and alloys. Increased academic research activities have also added to the demand for domestic production of various instruments for spectroscopic research.

The importance of spectroscopy in China is demonstrated by the publication, *Acta Physica Sinica* (Proceedings of Chinese Physics), two recent issues of which were devoted extensively to various branches of spectroscopy. Chinese scientists are interested in the application of spectroscopic technique to the analysis of minerals and ores and to ferrous and nonferrous metals, in the development of the most advanced types of automatic (nonphotographic) equipment, and in research in molecular spectroscopy and spectrophotometry.

Chinese technicians have constructed an electron microscope, the specifications of which have been claimed to equal the best of Western (serial) production. As is most probably the case of the advanced automatic spectrographic equipment, the construction of a single unit is far from significant serial production. It does, however, indicate a determined interest to be independent of foreign importation.

(7) *Plasma physics* — Research by the Chinese physicists in plasma physics includes mainly investigations of gas discharge phenomena. This work is conducted primarily at several institutes concerned with electronics research, including the Institute of Electronics. There may be a small effort to relate the theoretical aspects of such studies to thermonuclear reactions, but the main efforts are devoted to the generation of millimeter and shorter radio waves by various plasma methods. The latter efforts would be of great importance in developing radar techniques. Work at the Institute of Mechanics (*Li-hsueh Yen-chiu-so*), AS, Peiping, includes the study of the rocket propulsion aspects of plasma physics; for example, shock waves in ionized gases.

(8) *Solid state physics* — The overall quality of solid state physics in China is not impressive, but the quantity and scope appear to be adequate to satisfy the present needs of China. In China, there are no first-rate solid state physicists,

as judged on a worldwide basis. Most of the solid state physics research in China is done on semiconductors. This work involves investigations into photoconductivity, luminescence, deformation effects, special luminomagnetic effects, thermoluminescence, semiconductor generators and thermistors. (See also SECTION 71 of this NIS, for additional related information.)

Other aspects of solid state physics research conducted in China include the study of magnetic ferrites, soft magnetic materials, theoretical research on magnetism, crystallography, crystal structure, crystal growth and crystal synthesis, metal physics involving internal friction in metals, kinetics of alloy transformations, metal-ceramic high temperature compositions, and low temperature physics.

The main objective of Chinese research in solid state physics is to support the technological and engineering needs of the country. Consequently, work is being directed toward providing semiconductor and other solid state devices to advance aeronautical engineering, machine manufacturing, power engineering, radio engineering, metallurgy, computers, and nuclear power engineering.

The U.S.S.R. has extended material support to China's efforts in solid state physics research, particularly by providing certain special raw materials and parts of research apparatus. In some instances the entire research apparatus for a specific line of investigation has been forthcoming from the Soviet Union. Among the raw materials provided, semiconductors predominate.

In the last several years, Chinese scientists have attended only one international scientific meeting (a low temperature conference held in England) in solid state physics.

(9) *Theoretical physics* — Chinese research in theoretical physics is fairly readily discussed in their scientific literature. Chinese efforts are on a much smaller scale than similar efforts by Soviet and U.S. physicists. Individual Chinese, however, can be found who are highly competent and fully cognizant of the latest advances in their particular areas of interest. In theoretical nuclear physics, Chinese physicists have successfully derived a theoretical expression for the binding energies of light nuclei that gives 93.3% of the actual experimental values, namely by suitable combining of central and tensor forces and fitting with the results of collision experiments. A Chinese study of the shell model and so-called magic numbers has demonstrated that the multifold interaction of a nucleon with all internal nucleons is equivalent to polarization of the nuclear matter surrounding the particle. The binding energies of several shells also have been successfully calculated by Chinese theoretical physicists. They have determined the spectrum of low-lying excited levels of a number of nuclei. In the same area of theoretical nuclear physics, Chinese theoretical physicists are evidencing familiarization with the latest foreign efforts, for they have demonstrated that the theory of universal V–A Fermi weak interaction is superior to the Yukawa and other types of theories of universal weak interaction. In the area of statistical physics, Chinese theoretical physicists have proposed a new method for calculating the configurational free energy for a binary solid solution and have successfully applied it to practical problems. They have also proposed a successful phenomenological theory of the effects of volume viscosity on the dynamics of fluids.

A number of Chinese theoretical physicists have participated in the work of JINR. They played a large role in the recent discovery of a new elementary particle, the anti-sigma-minus particle, whose existence had been predicted by theory.

(10) *Upper atmosphere physics* — Some research in the comparatively new field of upper atmosphere and near-space physics is being conducted by the Chinese at their Institute of Upper Atmospheric Physics (*Kao-k'ung Wu-li Yen-chiu-so*), Wu-han. They have succeeded in measuring the upper atmospheric ozone as a function of altitude by the so-called single wave method. For this purpose, they have devised an instrument for detecting upper atmospheric ozone and also a magnetic indicator of the nuclear precession type for upper atmosphere research. (For additional information on this subject, see below under Astronomy and Upper Atmosphere Sciences.)

c. SIGNIFICANT RESEARCH FACILITIES

Institute of Atomic Energy (*Yuan-tzu-neng Yen-chiu-so*), *AS, Peiping*—Director: Ch'ien San-ch'iang since 1950. Until 1958 or early 1959, this institute (see FIGURE 76–21) was known as the Institute of Physics. It is the leading Chinese institute for research in theoretical and experimental nuclear physics, cosmic ray physics, and nuclear emulsions. This institute includes among its equipment the first Chinese research reactor, a 7-megawatt reactor supplied by the Soviet Union. The reactor, which has been in operation since 1958, is located about 19 miles southwest of Peiping. A 25-Mev. cyclotron (see FIGURE 76–17), also obtained from the U.S.S.R., has been installed at this institute. Indications are that the Chinese Communist government has considered construction of a 3-Bev. electron accelerator at this institute, but the lack of trained manpower

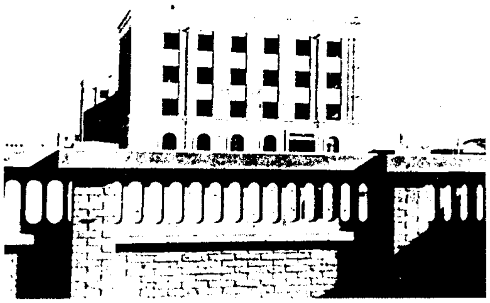

Figure 76–21. Institute of Atomic Energy, Peiping, 1958

has forced the cancellation or indefinite postponement of this project.

The staff of the institute includes some 100 scientists, including about 20 with advanced training in the United States and/or Europe. Most of the nuclear energy staff has been trained in the Soviet Union or by Soviet scientists in China.

The Accelerator Department (director: Dr. Chao Chung-yao) is believed to have in operation two Van de Graaff accelerators with energies of 2.5 Mev. and 0.75 Mev. The Cosmic Ray Laboratory (director: Dr. Chang Wen-yu, since 1956) has approximately eight to ten scientists engaged in research. These scientists also conduct research at the institute's high-mountain station, the Lo-hsueh Shan Cosmic Ray Observatory. Inadequate equipment precludes the undertaking of any major research. At the Laboratory of Theoretical Physics (*Li-lun Yen-chiu-shih*), probably headed by P'eng Huan-wu, members have conducted successful work in field theory, and have conducted a thorough review of the famous work of the Chinese-Americans, T. D. Lee and C. N. Yang, in particle theory. The work of this laboratory represents a valuable contribution to the total Chinese effort in theoretical physics. Current research at the laboratory is in the areas of elementary particle theory and field theory.

Institute of Computation Techniques (*Chi-suan Ch'i-shu Yen-chiu-so*), *AS, Peiping*—For information on this institute, see Section 71 of this NIS.

Institute of Electronics (*Tien-tzu-hsueh Yen-chiu-so*), *AS, Peiping*—Director: Ku Te-huan. This institute was founded in 1956. Although the total staff of the institute reportedly numbers about 2,000, there are only 20 senior scientists. Among the most competent scientists in this institute is a deputy director, Ma Ta-yu, the leading Chinese acoustician. Among the physics research being done here is work in semiconductors and in ultrasonic technology and electroacoustics. There is an Ultrasonics Laboratory under the direction of Ying Ch'ung-fu. There is some possibility that the acoustic work will be set up as an independent organization separate from this institute. (See also Section 71 of this NIS.)

Institute of Mechanics (*Li-hsueh Yen-chiu-so*), *AS, Peiping*—Director: Ch'ien Hsueh-sen since founding of the institute in 1956. Variant names of the institute are Institute of Dynamics and Institute of Kinetics. The Institute of Mechanics was part of the Institute of Mathematics until 1955–56. There are six major groups or departments of the institute: hydrodynamics, elasticity, combustion (chemical fluid dynamics), physical-chemical dynamics, plasticity theory, and operations research. This institute is regarded as one of the dozen or so most important institutes by the Chinese. The institute has conducted much successful research and development, some of which have been sent to the Ministry of National Defense for implementation by various military (ordnance) units. As early as 1957, enough work had been accomplished in the field of mechanics, primarily by this institute, to hold the First National Conference on Mechanics in Peiping to summarize results. Current research activities of the institute include both the theoretical problems of mechanics and also the practical problems of rockets and missiles in the space age. Such activities are conducted in cooperation with the nearby Institutes of Computation Techniques (*Chi-suan Chi-shu Yen-chiu-so*) and Automation and Remote Control (*Tzu-tung-hua Chi Yuan-chu-li Ts'ao-tsung Yen-chiu-so*), both in Peiping. The institute is also actively engaged in training teaching personnel for technical schools. Specific areas of research are high-speed aerodynamics, magnetohydrodynamics, rarefied gases, and allied topics related to important technical and scientific problems of the space age. The institute also accepts consultation and requests relating to basic research from the Ministry of National Defense. Cosmic ray experiments are to be conducted at the institute. Equipment of the institute includes a wind tunnel of moderate size and power suitable mainly for the instruction of students and for low-speed aerodynamic studies. An outstanding member of the institute is Kuo Jung-huai, who is noted for his work in dynamics and as an author of popular articles on such things as space travel.

Institute of Optics and Precision Apparatus and Instruments (*Kang-hsueh Ching-mi Chi-hsieh I-ch'i Yen-chiu-so*), *AS, Ch'ang-ch'un*—Director: Kung Tsu-t'ung. This institute, established in 1953, is also known as the Optical and Precision Instruments Research Institute, the Institute of Optical and Precision Machinery and Instuments, the Institute of Mechanics and Optics, and the Ch'ang-ch'un Optical Instrument Research Laboratory. In August 1957, there were about 400 employees. By 1959 the institute had produced, on a "trial production" basis, such complex instruments as an electron microscope and a semiautomatic recording infrared spectrometer. Earlier "trial products" included various types of spectrographs, microscopes, theodolites, and other precision optical instruments and also special optical glasses. No serial production has been reported.

Institute of Physics (*Wu-li Yen-chiu-so*), *AS, Peiping*—Director: Shih Ju-wei since 1954. This institute was formerly the Institute of Applied Physics. The present institute was established in 1950 from existing institutes, but actual research work did not start until 1953–54. The major departments or laboratories of the institute are concerned with semiconductors, metal physics, crystallography, solid-state luminescence or radiation physics, low-temperature physics, magnetism, and X-ray or spectral analysis (spectroscopy). The major achievements of the institute have been in the field of applied solid state physics and metal physics, as these subjects relate to the practical technological problems of electronics and metallurgy. Such applied work has contributed greatly to the technological and industrial advancement of the country in its early developmental stage. Current research activities of the institute mainly comprise general investigations into the structure and properties of matter and its changes under various conditions; e.g., investigations into the practical production of artificial diamonds under high temperatures and pressure and suitable catalytic conditions. As of mid-1957, personnel reportedly numbered about 300. The institute's equipment includes a German-made air liquefier, a Chinese-made (in 1954) hydrogen liquefier, and a number of Soviet-made spectrometers. The work of the institute is of fairly high caliber, but is hindered by lack of equipment and experienced personnel.

Lo-hsueh High Mountain Laboratory (*Lo-hsueh Kao-shan Shih-yen-shih*), *Lo-hsueh*—Director: probably Dr. Chang Wen-yu since 1956. This observatory is subordinate to the IAE, AS, and is also known as the Lo-hsueh Shan Cosmic Ray Observatory. The station, which began operation in 1955, is located at an altitude of 3,184 meters (10,443 feet) above sea level. The station is accessible by road from K'un-ming, a distance of approximately 50 miles. This laboratory is moderately well equipped, having two cloud chambers (one from the United States) and a large ionization chamber obtained from the Soviet Union. The personnel here come primarily from the IAE and are mostly students.

Nanking University (*Nan-ching Ta-hsueh*), *Nanking*—This university has a Chair of Acoustics headed by Dr. Wei Jung-chueh. Reportedly it is the training center for specialists in architectural acoustics, acoustics of speech and ultrasonics. Plans are being made to include work in molecular acoustics and hydroacoustics.

Shanghai Scientific and Industrial Instrument Research Institute, (*Shang-hai I-ch'i I-piao K'o-hsueh Yen-chiu-so*), *Shanghai*—Director: Lu Chu-min. The institute, established in November 1956, may be under the First Ministry of Machine Building Industry. Optical research is conducted by the Optical Devices Office of the Production Department. The main goal of this office is development of optical instruments for industry, with emphasis placed on theodolites and leveling instruments; work is also done on profile (opaque) projectors. In 1957, the Optical Devices Office employed about 50 people, including 4 specialists in optical instrument design who had just been graduated from Chekiang University. Research on a method of applying metallic coating to lenses is conducted by the Special Material Research Office, another branch of the Production Department. This office is also working on the development of a type of glass for lenses that will pass more infrared light than normal glass. The lenses are to be used with highly sensitive thermoelectric elements in low-temperature radiation pyrometers.

Wu-han Geophysical Observatory (*Ti-ch'iu Wu-li Kuan-hsiang T'ai*), *AS, near Hankow*—Director: unknown. This facility is also known as the Institute of Upper Atmosphere Physics. Major divisions are concerned with the study of the ionosphere, cosmic rays and atmospheric ozone and nightglow. Scientists recently successfully developed high-quality, high-altitude ozone detectors and high-altitude magnetometers of the nuclear precession type. This and other achievements will be of great value to future Chinese research in the field of the upper atmosphere and near-space physics. Current research activities concern upper atmosphere physics, as related to upper atmospheric aeronautics (rockets, guided missiles, high-flying aircraft) and to the improvement of radio communications via the ionosphere. The physics research aspects of the work at the observatory especially concern investigations into the physical processes occurring in the upper atmosphere.

d. OUTSTANDING PERSONALITIES

CHANG Wen-yü (1728/2429/5940), Dr.—Cosmic rays, nuclear physics. Director of the Cosmic Ray Laboratory of IAE, since 1956, and probably in charge of the Lo-hsueh Shan Cosmic Ray Observatory in Yunnan.

Taught at the Peiping University, 1958. Member of the Department of Physics, Mathematics, and Chemistry of the AS, since 1957. Member of the Chinese Physical Society. Member of the Physical and Philosophical Societies at Cambridge University. Attended: International Conference on High Energy Nuclear Physics in Geneva, 1958; the International Conference on Cosmic Radiation, in Moscow, 1959; the International Conference on High Energy Nuclear Physics in Kiev 1959. Studied in England, 1934–38. Research associate and visiting professor in the United States, 1943–56. Recent research: construction of a cloud chamber for use in cosmic ray research. Born: 1910.

CHAO Chung-yao (6392/1813/1031) (also known as CHAO Tsung-yao, CHOW, C. Y.), Prof. Dr.—Nuclear physics. Internationally known nuclear physicist and one of China's most outstanding scientists. Deputy director of the IAE, and in charge of the Accelerator Department of this institute. Member of the Scientific Council of JINR, 1957. On the editorial staff of the physics research journal *Wu-li Hsueh-pao,* 1951. Member of the Standing Committee of the Department of Physics, Mathematics, and Chemistry of the AS, 1955. He was educated in Germany, the United Kingdom, and in the United States, receiving his Ph.D. in 1930 from the California Institute of Technology. He also conducted research in the United States, 1946–50. He visited Poland in 1954 and traveled to Moscow in 1951 and 1956. The latter trip was in connection with the founding of JINR. He was credited by a noted U.S. physicist with the discovery of gamma rays, which are produced by the annihilation of a positron and a negatron through collision. Recent research: atomic energy. Born: 1902.

CHAO Kuang-tseng (6392/1684/1073), Prof.—Optics and spectroscopy. Associated with the Department of Physics, Peiping University. Also associated with the former Institute of Applied Physics, 1956 (possibly now with the Institute of Physics). Studied in the United States, about 1937–40, receiving an M.S. degree from the University of Michigan in 1938. Attended the Sixth International Colloquium on Spectroscopy, Amsterdam, 1956. Has recently indicated some interest in semiconductors. Born: 1902.

CHAO Yuan (6392/0337), Prof.—Optics. Associated with the Optical Devices Office, Production Department, Shanghai Scientific and Industrial Instrument Research Institute. Professor in optics at Chekiang University. Engineer in Shanghai General Instrument Factory. Born: about 1905.

CH'IEN Hsueh-sen (6929/1331/2773) (TSIEN Hsue-shen), Prof. Dr.—Aerodynamics and space-age physics, associated with rocket technology. A brilliant physicist and one of world's foremost authorities on aerodynamics and advanced propulsion schemes, including nuclear and chemical propulsion. He represents Communist China's single greatest asset in the new and important field of missiles, satellites, and rockets. Director of the Institute of Mechanics since its founding in 1956. He is also chairman of the Department of Dynamics and Dynamic Engineering in the China University of Science and Technology. At the California Institute of Technology in 1950's, where he was the Goddard Professor of jet propulsion. During 1939–46, he was in close contact with almost all of the classified work being done in the United States in aerodynamics and nuclear propulsion; he also assisted in certain phases of the work on the first atom bomb. In Communist China he served as a member of the Awards Committee of the AS, 1955. Member of the Department of Physics, Mathematics, and Chemistry of the AS, since 1957. He visited the U.S.S.R. in 1956–57. Received Ph.D. in aeronautical engineering from the California Institute of Technology in 1939, studying under the famous aerodynamicist, Theodore van Karman. Previously, studied at the Massachusetts Institute of Technology. He is a member of the Chinese Communist party. Recent research: high-speed aerodynamics, cybernetics, automatic control, general mechanics, rocketry, and other areas of space-age physics. Born: 1909.

CH'IEN San-ch'iang (6929/0005/1730), Dr.—Nuclear physics. Director of the IAE, 1950–60. Officer of the Chinese Physical Society, 1953. Member of the Standing Committee of the Department of Physics, Mathematics, and Chemistry of the AS, 1955. Received the Physics Prize of the French Scientific Institute in 1946 for work in nuclear physics. Studied and worked in France, 1937–48, receiving a Ph.D. degree from University of Paris in 1943. Traveled to the U.S.S.R. in 1951, 1953 and again in 1956. The last trip was in connection with the founding of JINR. He is best known for work done in the discovery of the third and fourth phases of nuclear fission. Since 1949 he has conducted little research, since he is primarily interested in administrative work. Born: 1913.

CHOU P'ei-yüan (0719/1014/3293), Prof. Dr.—Theoretical physics. One of the country's more outstanding theoretical physicists. Vice president and physics professor at Peiping University. Dean of the university, 1952–56, and also director of the Pedagogical Research Unit of Dynamics, Department of Mathematical Dynamics of the University in 1954. Member of the Standing Committee of the Department of Physics, Mathematics, and Chemistry of the AS, 1955. Director of the Chinese Physical Society, and a member of several other scientific societies. In 1950 he was director of the Organization Department of the All-China Federation of Scientific Societies. He serves on the editorial board of several professional journals. He has also served as a member of the Atomic Energy Utilization Committee (1955); Scientific Scholarship Committee of the academy (1956); and State Council Scientific Planning Commission (1956). He has attended a number of international conferences; served as secretary of the World Federation of Scientific Workers in 1959. He has visited numerous foreign countries. Received his doctorate degree from the California Institute of Technology in 1928, and previously studied at the University of Chicago in 1926–27. Current work is mainly administrative, but he often acts as an official spokesman of Communist Chinese science. He has conducted significant research in theoretical physics, specifically in relativity theory, aerodynamics, fluid dynamics, hydrodynamics and allied areas. Born: 1902.

HO Tse-hui (0149/3419/1979) (Madam CH'IEN San-ch'iang), Dr.—Cosmic rays and nuclear physics. Associated with the IAE. Received Joliot-Curie award for work in 1946, in collaboration with her husband, in discovery of the third and fourth phases of nuclear fission. In January 1956, received the Third Class Science Award in Physics, AS, for her work in preparing nuclear emulsions. Delegate to Congress of Women's International Democratic Federation in Denmark, 1953. Studied at the University of Berlin, receiving a Ph.D. in 1940. Recent research: nuclear emulsions. Date of birth: unknown.

HSIAO Chien (5618/0256) (Robert C. Hsiao)—Cosmic rays. Associated with and probably deputy director of the Cosmic Ray Laboratory of the IAE. Studied in the United States, 1947–50. Recent research: cosmic ray research using a Wilson cloud chamber. Born: 1920.

HSU Hsien-yu (1776/3759/3842), Prof. Dr.—Computers and programming. Member of the Institute of Computation Techniques of the AS, since 1956, and head of Electronic Computer Laboratory of Peiping University since 1956. Professor of mathematics at Yenching University, 1938–46. Member of the Preparatory Committee, Institute of Computing Technology, 1956. Studied in the United States at Washington University, St. Louis, 1936–38. Traveled to the U.S.S.R. to attend a conference on computers in March 1956 and later studied computer programming in the U.S.S.R. Date of birth: unknown.

HU Ning (5170/1380), Prof. Dr.—Theoretical physics and nuclear physics, including elementary particles. One of the leading theoretical physicists and head of a section of the Laboratory of Theoretical Physics of JINR. A member of the Institute of Physics, AS, in 1953; physics professor at Peiping University, 1953–57; and assistant head of the university's Theoretical Physics Department. Member of the Department of Physics, Mathematics, and Chemistry, AS in 1955, and member of the Scientific Council of JINR, in 1957. He has visited numerous foreign countries. Received doctorate degree in 1944 from California Institute of Technology, and in 1955 studied at the Institute for Advanced Studies, Princeton. Recent research: meson physics (e.g., meson-nucleon scattering) and allied areas of elementary particle theory (e.g., strange particles, strong interactions, etc.). Born: 1915.

HUA Lo-keng (5478/5012/1649), Prof. Dr.—Theory of numbers and theory of functions, computers. Hua is generally considered to be the leading Chinese mathematician and is best known for his earlier work on theory of numbers and later work on theory of functions; presently is concerned with scientific administration. Director of the Institute of Mathematics of the AS, since 1951, and deputy director of the academy's Department of Physics, Mathematics, and Chemistry. Professor of mathematics of National Tsinghua University 1937–41. Obtained a D.Sc. degree from Cambridge University about 1936. He came to the United States in 1946 to make a study of nuclear energy in this country for the Chinese National Government and was a professor of mathematics at the University of Illinois until his return to China in 1950. In 1948, Hua was elected a member of the Mathematical and Physical Sciences Group of the Nationalist Academy of Sciences. Since 1950, he has been director of the International Liaison Department of the National Committee of the All-China Federation of Scientific Societies. He received a first prize of the Ministry of Education for his work on number theory in 1942 and a first prize from the AS in 1957. In 1956, Hua headed a planning committee which organized the Institute of Computation Techniques and was named a member of the Scientific Planning Committee of the State Council the same year. Hua has continued to play a very active part in the direction of Chinese computer developments. He has been very active with respect to the Institute of Computation Techniques. Hua lectured in the U.S.S.R. in 1946 and attended a conference in Leningrad in 1954. He has also attended an International Conference on Relaxing World Tension in Stockholm in 1954 and the Fourth General Assembly of the World Federation of Scientific Workers in Berlin in 1955. Hua is an important Communist and is very active in organizations which direct propaganda related to science, scientific workers, and world peace. He is presently active in scientific administration, propaganda, and conducts research on theory of functions in addition to training students. Born: about 1910.

HUANG K'un (7806/2492)—Semiconductors. Director of the Laboratory of Semiconductors of AS, 1957. Staff member of the Physics Department of Peiping University, from about 1946–56; director, 1957. Probably former head of the Semiconductor Research Section of the Institute of Applied Physics (now the Institute of Physics), 1956. Member of the Department of Physics, Mathematics, and Chemistry of AS. Member of the editorial board of the physics journal *Wu-li T'ung-pao*, 1954. Possibly educated in England and Scotland. He is known to have worked on the theory of the R-center and the ionic lattice. Date of birth: unknown.

MA Ta-yu (7456/1129/3731), Dr.—Acoustics. Leading acoustics specialist in China. Deputy director of the Institute of Electronics since 1956. Associated with the Chinese National University at Peiping, 1958. Associated with the former Institute of Applied Physics, 1956. Fellow of the Acoustical Society of America. President of the Electronics Society of China, 1957. Studied in the United States for several years, receiving his Ph.D. from Harvard in 1940. Recent research: study of sound absorption in solids and, to some extent, in liquids. Born: 1915.

SHIH Ju-wei (2457/3067/3634), Prof. Dr.—Theoretical physics, specializing in solid state physics. Director of the Institute of Physics, AS, since 1954. Physics professor at Tsinghua University in 1940 and research fellow in pre-Liberation Institute of Physics at the Nationalist China's Academy of Sciences during the period 1936–43. He has been a member of the Department of Physics, Mathematics, and Chemistry of AS, since May 1955, and also a member of the Peiping branch of the Chinese Physical Society since 1954. In December 1954, he served as the representative of the Natural Science Organization of some 24 scientists in the Second National Committee of the Political Consultative Conference. In 1957 he visited the U.S.S.R. Previously, studied in the United States, receiving his Ph.D. from Yale University. Recent research: optics and magnetics (e.g., anisotropy of the ferrous elements and alloys), and other allied fields concerned with the theoretical investigation of the properties of matter. Born: 1902.

WANG Kan-ch'ang (3769/3227/2490), Dr.—Nuclear physics, cosmic rays. Deputy director of IAE; deputy director of JINR, since January 1959. Member of the Department of Physics, Mathematics, and Chemistry of the Chinese Academy of Sciences. Member of the Chinese Society of Physics. Head of the Working Group on Cosmic Rays of the Chinese National Committee for the IGY in 1957. Member of the preparatory committee for the First All-China Scientists' Conference, 1949. Attended the International Conferences on High Energy Nuclear Physics in Moscow, 1956, and in Kiev, 1959. Attended the International Conference on High Energy Accelerators and Instrumentation in Geneva, 1959. Studied in Germany, receiving a Ph.D. degree from the University of Berlin in 1934. Studied in the United States, 1947–48. Recent research: Fundamental particles. Wang and other scientists from JINR claimed to have observed at least two particles in 1959 and 1960 which have not as yet been observed elsewhere. The discovery of the first of these particles, the existence of which had not been predicted by theory, has not been confirmed. Western physicists have, however, authenticated the discovery of the second particle, an anti-sigma-minus hyperon. Born: 1907.

WANG Shou-wu (3769/1343/2976), Dr.—Engineering mechanics, transistors. Associated with the Laboratory of Semiconductors. Associated with the former Institute of Applied Physics from 1951–57, and with the Semiconductor Laboratory of this institute in 1957. Wang studied in the United States from 1945 to 1950, receiving his Ph.D., probably in engineering mechanics, from Purdue University. Research has concerned semiconductors, photoelasticity, and plastic state phenomena, but no estimate of his technical proficiency is available. Born: 1919.

WU Hsi-chiu (0702/6832/0046) (Robert Shih-chiu Wu)—Electrical engineering and transistors. Associated with the Institute of Semiconductors since 1956. In the United States, studied electrical engineering at the Massachusetts Institute of Technology and, subsequently, was employed by Crosley Corporation, Cincinnati, Ohio. Research has concerned: transistors, with particular emphasis on circuit analysis and servomechanisms. Recent work has been on tube design. Born: 1932.

YING Ch'ung-fu (2019/1504/4395), Dr.—Acoustics, solid state physics. Director of the Ultrasonics Laboratory of the Institute of Radio Engineering and Electronics Research, 1959. Attended the Fourth All-Union Conference on Acoustics in Moscow, 1958. Studied and taught in the United States from 1949 to 1956, receiving a Ph.D. degree from Brown University in solid state physics in 1952. According to a U.S. physicist, he is a highly competent physicist with interests in solid state physics, general theoretical physics and applied mathematics. Recent research: ultrasonic damping in solids, measurement of the velocity of sound, and industrial applications of ultrasonics. Born: 1915.

6. Mathematics

a. GENERAL

(1) *Capabilities and trends* — Communist Chinese mathematicians are doing limited research in most of the major fields of mathematics, and their program is expanding. Greatest strength and activity—although still rated only moderate at best in comparison with Western and Soviet work—is in theory of functions, differential equations, and parts of differential geometry and algebra. Some work is also being done in topology and theory of numbers. Important weaknesses exist in areas of the theory of probability and mathematical statistics, computational mathematics, and mathematical logic, where work is just getting started. Nevertheless, capabilities are limited by a lack of suitably trained people; most of the research is being done by less than fifty mathematicians who have received their advanced training in Western countries and in the U.S.S.R.

The present overall emphasis of the expanding Chinese Communist mathematics program is on providing suitable problem-solving capabilities in the technical sciences to support economic and military programs, as well as on examining existing mathematical methods in order to acquire new techniques and to develop simplifications of existing problem-solving techniques. Integration of theory and practice is accented in their training programs. These programs are aimed at rapidly increasing the number of people who can give direct mathematical support to projects of economic and military importance and at training mathematics instructors for Chinese colleges. Participation in international activities with Western countries outside the Sino-Soviet bloc has been very limited, but there has been considerable cooperation and exchange with the U.S.S.R. Chinese Communist mathematicians also have attended conferences in European bloc countries and in India.

(2) *Background and organization* — Mathematics in China has a history of many centuries and many remarkable results obtained at a very early date. For example, by about the middle of the 5th century, Chinese mathematicians had calculated a value of the constant "pi" accurate to more than seven decimal places. Methods for approximating roots of algebraic equations were developed before the 14th century. This earlier work was followed by a period of stagnation and some retrogression, and a lag behind Western countries which has extended up to the present. Although Chinese scholars were acquainted with mathematical trends and developments in Europe prior to the 20th century, the shift to development of mathematics in the more modern sense was not made until about 1930. The transition was not abrupt in all areas, and they have a long tradition in some areas such as algebra. Between 1930 and 1948, major emphasis was on theory of numbers, algebra, differential geometry and on some aspects of topology. Much of the work accomplished prior to 1949 was carried out by mathematicians connected with Peiping, Tsinghua, Chekiang, and Nankai Universities. An Institute of Mathematics (*Shu-hsueh Yen-chiu-so*), Peiping, was established in 1946. Since the establishment of the Communist Chinese regime in 1949, the major institute for conducting mathematics research has been the Institute of Mathematics of the Chinese Academy of Sciences (*Chung-kuo K'o-hsueh-yuan*), AS, Peiping. The overall authority for direction and planning of work in mathematics at present is the State Planning Committee for Science and Technology of the State Council. The actual work, however,

is heavily concentrated in the institutes of the Department of Mathematics, Physics, and Chemistry of the AS and in the higher educational institutions under the Ministry of Education (*Chiao-yu Pu*). Geographically, Chinese Communist mathematics work is concentrated in the Peiping and Shanghai areas. At all levels, the organization of Chinese Communist mathematics has Communist Party representatives who decide what subjects are to be taught and what research projects are to be pursued, and who select personnel. Special problem assignments are given to the individual mathematicians through the AS, and mathematicians are often assigned to work directly with industrial organizations in solving practical engineering problems.

b. MAJOR RESEARCH AND DEVELOPMENT BY FIELD — Chinese Communist mathematical developments have been general and the greatest concentration has been on expansion of capabilities for mathematical support to a large number of projects of economic and military importance. Some work on theoretical mathematics has been accomplished, but no spectacular results have been reported. The current emphasis is on integrating mathematical theory with practice, and giving priority to projects which will further the economy.

Published works indicate that considerable attention has been given to mathematical research connected with solving problems in fluid mechanics, aerodynamics, supersonic flight, and deformation of thin shells. Some work in the theory of plasticity also has been reported. Most of the major subtopics of mathematics also are being treated, with emphasis on topics which can be applied directly or which are needed for the development of new applied mathematical methods. Work on specific topics of pure and applied mathematics is described below.

(1) *Differential equations* — Almost every university or engineering college has a group concentrating on differential equations. Work on the theory of ordinary differential equations has concentrated on stability of systems described by a differential equation and on existence and uniqueness of solutions. Work on partial differential equations has been concerned with uniqueness theorems, with systems of equations connected with the theory of thin shells, and with partial differential equations which arise from capillary phenomena. Workers in differential equations have participated in work on design of large dams, numerical weather prediction, oscillation of large machines, and design of winged aircraft.

(2) *Theory of probability and mathematical statistics* — Work on theory of probability and mathematical statistics has been initiated only in the last few years but is expanding. Within the last two years, higher educational institutions have begun to attach increased importance to the topic. Work has centered around the analytic theory of probability, Markoff processes, forecasts for stationary processes, and distributions. Research workers go directly into industrial organizations to aid in production problems. For example, they have contributed to solution of problems in the textile industries and in construction industries.

(3) *Computational mathematics* — Work on computational mathematics has just begun, but considerable importance is attached to it. Chinese Communist work has received assistance from Soviet specialists. Emphasis is on methods suitable for use on high speed computers.

(4) *Operations research* — Work on operations research is scattered throughout China and has been concerned particularly with construction efforts and with economic planning on a nationwide scale. Most of the work has been on linear programming problems and on simplified methods of solving such problems.

(5) *Mathematical logic* — The Chinese Communists are still weak in mathematical logic but plan expansion. In the theory of deductive logical systems, emphasis has been on bivalued and multivalued logic and axiomatic methods. The theory of recursive functions has also been studied in connection with approximation methods. Application of the work of Chinese logicians to computer design began in 1958.

(6) *Theory of numbers* — Chinese work on number theory has been traditional; some good work is still carried on in classical analytic theory of numbers, probably due to the presence of Hua Lo-keng. Some well-known Soviet and Western works have been extended. Distribution of arithmetic functions and of prime numbers have been studied.

(7) *Algebra* — The Chinese have a long tradition of work on algebra and some work has been continued since 1949. Emphasis has been on projective geometry, matrix and tensor algebra, and group theory. At least a part of their work in algebra appears to be basic to development of new mathematical methods which could find wide application in science and technology.

(8) *Differential geometry* — Chinese geometers laid a foundation for research on differential geometry prior to 1949. In the past decade, this work has been extended. Reported interests

include differential transformations in non-Euclidean spaces and the behavior of differential equations in non-Euclidean spaces. Some of this work could be useful for development of methods for solving problems connected with the interaction of radiation with matter.

(9) *Topology* — Topological mappings have been emphasized. Part of the Chinese work in this field appears to be connected with development of methods for treating fiber spaces and fiber bundles which, in turn, provide methods of attack on some problems of fluid flow and similar applications.

(10) *Functional analysis* — The younger Chinese mathematicians increasingly are becoming interested in functional analysis. They have worked on integral equations, integro-differential equations, and linear operators. Much of the work appears to be directed toward development of methods of solving differential and integral equations.

(11) *Theory of functions* — Almost a third of the mathematical papers published in Communist China in the past decade have been concerned with theory of functions. Chinese mathematicians, besides having had a foundation in this field established prior to 1949, also have studied Soviet work. They have been concerned particularly with approximation methods and other areas which support work on differential equations and numerical calculations. Work on theory of functions will probably be expanded to include study of functions of several complex variables and special functions which arise in problems in technical sciences.

c. SIGNIFICANT RESEARCH FACILITIES

Futan University (Futan Ta-hsueh), Shanghai—This university has several departments; only the Department of Mathematics and Mechanics is of interest here. The chairman of this department is presently unknown but is probably either Su Pu-ch'ing, who is also vice president of the university, or Ch'en Chien-kung. The greatest research effort has concerned differential geometry and mappings and functions of complex variables and analysis of Fourier series. Most of this research is concentrated in the hands of a few mathematicians who are also members of the Institute of Mathematics of the AS. A laboratory of mathematics, under the joint sponsorship of the Ministry of Education and the AS, was established in 1955–56.

Institute of Mathematics (Shu-hsueh Yen-chiu-so), Peiping—Director: Hua Lo-keng since 1956. This institute is subordinate to the Department of Mathematics, Physics and Chemistry of the AS, which is, in turn, subordinate to the (State) Scientific and Technological Commission. A branch of this institute has been formed in Shanghai. This institute is the major mathematical research facility in Communist China. The primary objective of the institute is to provide support to projects of military and economic importance and to aid in planning for facilities to provide such support. Most of the Chinese Communist work in advanced mathematics is either conducted under the direct supervision of the AS or in coordination with this institute. There is also close cooperation between this institute and industrial and probably also military organizations. Most of the outstanding Chinese Communist mathematicians are members of the institute and work on problems for Chinese industry assigned by the institute, even though they may be working at plants at widely scattered geographical locations. Many of these people are also members of university faculties. Most of the major topics of mathematics are being studied, with the greatest efforts being devoted to differential and integral equations and to functional analysis. This facility is also the major Chinese Communist center for training of graduate students. The institute apparently has large library facilities which include most of the important mathematics journals from all over the world.

Peiping University (Pei-ching Ta-hsueh), Peiping—This university is under the Ministry of Education and has several departments; only the Mathematics Department is of interest here. This department was chaired by Tuan Hsueh-fu in 1959. Research is conducted in most of the major topics of mathematics, primarily by a few staff members who are also members of the Institute of Mathematics of the AS; however, the major concern of this department is to train undergraduate students. A Computer Section has been established and work on development of mathematics for computer applications is underway.

Tsinghua University (Ching-hua Ta-hsueh), Peiping—President: Chiang Nan-hsiang. This university is subordinate to the Ministry of Education and has several departments; only the Department of Mathematics is of interest here. Chairman of this department is believed to be Chien Wei-chang, who is also vice president of the university. Research is conducted by a few prominent Chinese Communist mathematicians who are also members of the Institute of Mathematics of the AS. While there is some work on most of the major areas of mathematics, greatest concentration is on differential and integral equations. The major activity of this department is devoted to training undergraduate students and to providing mathematical support to projects of economic importance.

d. OUTSTANDING PERSONALITIES

CH'EN Chien-kung (7115/1696/0501)—Theory of functions. He has been highly respected by other Chinese mathematicians for many years and has been a leading contributor to Chinese work on series approximations of functions. He has been a professor of mathematics at Futan University at Shanghai since about 1954, and is one of the directors of a mathematical research center in Shanghai which was established under the AS and the Ministry of Education in 1956. He has also been a member of the Institute of Mathematics of the AS since the early 1950's and a member of the standing committee of the Department of Physics, Mathematics, and Chemistry since 1955. Ch'en was director of the Institute of Mathematics of the AS in 1947, when he left to accept a fellowship at Princeton University in the United States. He has been active in the Chinese Mathematical Society and was a vice president of the society in 1959. He also has served on the editorial committee of *Acta Mathematica Sinica* (Chinese Mathematics Journal) since 1954. Ch'en studied at the Tokyo Imperial University in Japan, 1914–20, and at Princeton University in the United States. He spent 1945–46 in Formosa. He is reported to be a Communist but takes little or no part in political activity. Born: about 1890.

CH'IEN Hsueh-sen (6929/1331/2773) (TSIEN Hsue-shen), Dr.—Fluid mechanics, aeronautical engineering, and applied mathematics. Dr. Ch'ien is one of the world's leading aeronautical and jet propulsion engineers and the leading Chinese Communist figure in development and application of mathematical methods for the solution of problems which occur in fluid mechanics. He has been director of the Institute of Mechanics of the AS since its formation in 1956. Prior to his return to China, he was a member of several U.S. societies. In March 1957, he became the first president of the Chinese Mechanics Society. Since 1956, he also has been a member of the Scientific Planning Committee of the State Council. He was a Goddard Professor at the Guggenheim Jet Propulsion Laboratory of the California Institute of Technology, 1949–55, prior to his return to China. He received a first prize from the AS in January 1957. Visited the U.S.S.R. in 1956 and studied and worked in the United States, 1935–55. He is a Communist Party member and, upon his return to China in 1955, he carried on strong propaganda activities. Ch'ien presently conducts research in mathematical methods for solving fluid mechanics problems. Born: 1909.

HUA Lo-keng (5478/5012/1649), Prof. Dr.—Theory of numbers and theory of functions. Although presently concerned with scientific administration, Hua is generally considered to be the leading Chinese Communist mathematician and is best known for his earlier work on theory of numbers and for his later work on theory of functions. He has been director of the Institute of Mathematics of the AS since 1951 and deputy director of the academy's Department of Physics, Mathematics, and Chemistry. He was a professor in the Department of Mathematics of National Tsinghua University before going to England, where he obtained a D.Sc. degree at Cambridge University about 1936. From 1937–41, he was again a professor of mathematics at National Tsinghua University. He came to the United States in 1946 to study nuclear energy for the Chinese National Government and was a professor of mathematics at the University of Illinois, until his return to China in 1950. In 1948, Hua was elected a member of the Mathematical and Physical Sciences Group of the National Academy of Sciences. Since 1950, he has been director of the International Liaison Department of the National Committee of the All-China Federation of Scientific Societies. He received a first prize from the Ministry of Education for his work on number theory in 1942 and a first prize of the AS in 1957. In 1956, Hua headed a planning committee which organized the Institute of Computation Techniques and also was named a member of the Scientific Planning Committee. Hua has continued to play a very active part in the direction of computer developments in Communist China. Hua lectured in the U.S.S.R. in 1946 and attended a conference in Leningrad in 1954. He also attended an International Conference on Relaxing World Tension in Stockholm in 1954 and the Fourth General Assembly of the World Federation of Scientific Workers in Berlin in 1955. Hua is an important Communist and is very active in organizations which direct propaganda related to science, scientific workers, and world peace. He is presently active in scientific administration and propaganda. He conducts research on theory of functions, in addition to training students. Born: about 1910.

SU Pu-ch'ing (5685/2975/7230), Prof. Dr.—Projective and differential geometry, especially on projections of curves and surfaces. Besides being a leading Chinese Communist mathematician in these fields, Su is also a leader in a political and organizational sense. He has been vice president of Futan University in Shanghai since 1957 and a professor of mathematics there since 1953. He has also been a member of the Institute of Mathematics, AS, since 1950, and in 1956, was one of the directors of a mathematical research center in Shanghai established under the AS and the Ministry of Education. Professor at National Chekiang University of Hangchow from about 1937 to about 1953 and a member of the AS since about 1947. He has also served on the editorial board of the mathematics journal (*Shu-hsueh Hsueh-pao*), published by the AS since 1954. In 1957, the academy awarded Su second prize of 5,000 yuan for work on the theory of curves in projective space. He has served on the Science Scholarship Committee and on the Standing Committee of the Department of Physics, Mathematics, and Chemistry of the AS, since 1955, and on preparatory committees for establishing mathematics research centers. Su attended the Tokyo Imperial University in Japan, from which he received his doctorate. In 1955, he was a member of a Chinese scientific mission to Japan and returned in 1956 to tour academic centers in Japan. He visited and attended conferences in Bulgaria in 1956 and in Rumania, Hungary, and the U.S.S.R. in 1958. He also studied in the U.S.S.R. during World War II and subsequently visited in the United States and in England. He has been active in pro-Communist organizations, including the Hangchow branch of the Sino-Soviet Friendship Association in 1949, the National Committee of the All-China Federation of Scientific Societies since 1950, and the China People's Political Consultative Conference, 1955–56. Whether or not he is a member of the Communist Party is unknown. Born: 1902.

WU Wen-tsun (0702/2429/0193)—Topology and geometry. Wu has won an international reputation for his work in topology and is held in especially high esteem by the Soviets. He has been a member of the Geometry Section of the Institute of Mathematics of the AS since 1952. He studied in France and was a professor at the Peiping University until 1952. Wu received a first prize of the AS in 1957. He has traveled to several Soviet bloc countries for lectures, including attendance at a conference in Rumania in 1958. Wu's attitude toward politics is one of complete disinterest.

7. Astronomy and upper atmosphere sciences

a. GENERAL

(1) *Capabilities and trends* — Communist China has only a few outstanding scientists working in astronomy and the upper atmosphere sciences. Although progress has been made, the country remains far behind the leading nations of the world in these areas. Much of the work has been in practical and solar astronomy, ionospheric physics, and high altitude cosmic ray investigations. Routine observational programs have been established and are maintained and a start has been made in radioastronomy. The principal effort in recent years has been in training young scientists, enlarging research programs, and in expanding facilities. The industry of the country has produced some of the simpler instruments, most of which have been copies of Soviet or Western models. The greatest deficiency in equipment is the lack of large, modern instruments. FIGURE 76–22 shows a 120-power reflecting telescope produced by the Nanking Scientific Instrument Plant.

In 1956, a group of leading Soviet astronomers and astrophysicists visited all institutes and observatories in the country, assisting the Chinese in formulating a plan for research projects. The Soviet bloc, particularly the U.S.S.R., has provided other technical assistance and some training and equipment. The Communist Chinese also have been able to purchase some instruments from Western countries. Other priorities or budget restrictions apparently have prevented large imports of foreign equipment.


FIGURE 76–22. 120-POWER REFLECTING TELESCOPE PRODUCED BY THE NANKING SCIENTIFIC INSTRUMENT PLANT

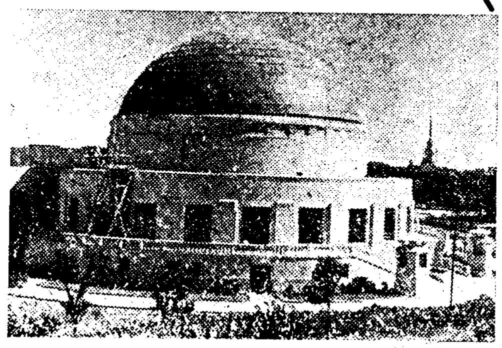
FIGURE 76–23. PEIPING PLANETARIUM, 1957

Projects completed in the last few years include construction of the Peiping Planetarium (see FIGURE 76–23) and a new latitude station. The most ambitious astronomical project in progress is construction of the Peiping Astronomical Observatory (*Pei-ching T'ien-wen-t'ai*), Peiping, planned to supplant the Purple Mountain Observatory (*Tzu-chin-shan T'ien-wen-t'ai*), Nanking, as the largest and most important observatory in Communist China. A concurrent project is the Peiping Radio-Astronomical Observatory. It is not clear whether the latter project will be maintained separately or will become a part of the Peiping Astronomical Observatory.

Various reports indicate that the Communist Chinese have a long-range upper atmosphere and space research program which eventually is to include the use of rockets and artificial satellites. Reportedly, Chinese officials have stated that they expect to launch an artificial earth satellite by 1964 and a lunar probe by 1969. The Chinese probably could provide some scientific instrumentation should launching vehicles become available, but considerable Soviet aid would be required to undertake this project. They now cooperate with the U.S.S.R. in satellite tracking. Communist Chinese space activities seem to be centered around Dr. Ch'ien Hsueh-sen, U.S.-trained director of the Institute of Mechanics (*Li-hsueh Yen-chiu-so*), AS, Peiping. The Institute of Geophysics and Meteorology (*Ti-chiu Wu-li Yen-chiu-so*), Peiping, and other academy institutes, also appear to be cooperating in this work.

The scientific effort of Communist China in astronomy and upper atmosphere research is expanding steadily. By exploiting the results of similar research in the rest of the world, in conjunction with their own efforts, the Communist

Chinese are in a position to give minor but slowly improving support in these sciences to communications and space activities and to various other fields of military significance such as geodesy, tracking, navigation, time service, meteorology, and development and use of missiles.

The strong control which Chinese Communist political leaders exercise over science is illustrated by the withdrawal in 1957 of the country from participation in the International Geophysical Year (IGY). Although plans had been formulated for participation, and Chinese astronomers and geophysicists would have benefited considerably therefrom, they were forced to withdraw—undoubtedly against their will—because Nationalist China was included in the program. Similarly, in 1959, because of Nationalist China's participation in the International Astronomical Union (IAU), Communist China withdrew its membership from that organization.

(2) *Background and organization* — There are indications that the Chinese traditionally have had some knowledge of astronomy, but most of their findings were lost or have been superseded by foreign accomplishments. European methods were introduced at Peiping by Jesuit missionaries in the 17th century. Although ancient observatories existed in Peiping and other cities, the oldest permanent observatory is probably Zikawei Observatory (*Hsu-chia-hui T'ien-wen-tai*), founded outside of Shanghai in 1873. However, despite this background, no modern major achievements or advances in astronomy or upper atmosphere geophysics can be credited to Communist China.

Upon taking control of the mainland of China in 1949, the Communist Chinese State Council organized the Academy of Sciences (*Chung-kuo K'o-hsueh-yuan*), AS, Peiping, to take over the facilities of the former *Academia Sinica*, including the Purple Mountain Observatory and the other astronomical and geophysical research installations. These remain under the direction of the AS. Overall planning and coordination of astronomical and upper atmosphere research is under the (State) Scientific and Technological Commission. Other important organizations which influence astronomical and upper atmosphere research are the Astronomical Society of China (*Chung-kuo T'ien-wen Hsueh-hui*), the Geophysical Society of China (*Chung-kuo Ti-ch'iu Wu-li Hsueh-hui*), and the China Society of Physics (*Chung-kuo Wu-li Hsueh-hui*). These societies, in cooperation with the academy, publish the leading scientific journals in their respective fields. Principal training activities are centered at Nanking University (*Nan-ching Ta-hsueh*), Nanking, and the Purple Mountain Observatory, although Peiping University (*Pei-ching Ta-hsueh*), Peiping, and Wu-han University (*Wu-han Ta-hsueh*), Wu-ch'ang, offer some instruction in upper atmosphere geophysics. Most of the leading scientists in these fields obtained their advanced training in the United States or in Europe. Apparently, the U.S.S.R. is now providing training for a relatively small but significant number of younger scientists.

b. MAJOR RESEARCH AND DEVELOPMENT BY FIELD

(1) *Practical astronomy* — Problems such as the determination of time, latitude, and longitude, because of their practical applications, have occupied much of the effort of Communist Chinese astronomers in recent years. The Purple Mountain Observatory, Nanking, is the best equipped observatory for latitude and longitude determinations. In preparation for the IGY, the Tientsin Latitude Station was founded. Zikawei Observatory (*Hsu-chia-hui T'ien-wen-t'ai*), Shanghai, the center of the national time service, has a number of good clocks in its new time laboratory. Purple Mountain Observatory, as the center for tracking artificial satellites, had a network of 26 observation stations over the country by 1959. These stations use as their basic instrument the small Soviet Model AT–1 wide-angle telescope, but two sets of Soviet precision photographic equipment are also in use for tracking satellites. Purple Mountain Observatory also predicts the passage of satellites. The ephemerides for the early Sputniks were very inaccurate in the beginning, but have improved steadily as Communist Chinese astronomers have gained experience. On short-term predictions, the accuracy was claimed as ± 1 minute and ± 1 degree by the end of 1958. Considering the size and needs of Communist China, facilities are inadequate and capabilities are very low in practical astronomy, but improvements have been made in recent years.

(2) *Solar astronomy* — Communist Chinese astronomers have placed considerable emphasis on solar research, probably because such studies are closely linked with geomagnetic, communications, meteorological, and many other important problems. The Purple Mountain Observatory; Zo Se Observatory (*She-shan T'ien-wen-t'ai*), Shanghai; and probably K'un-ming Astronomical Observatory have special instruments, including spectroheliosopes, for solar observations. At least one Lyot Heliograph is available. The new Peiping Observatory is equipped with a Soviet chromospheric telescope. An expedition, composed of about 80 Communist Chinese and Soviet

Figure 76–24. Equipment used in making solar and radioastronomical studies on Hainan Island, 1958

astronomers, studied the solar eclipse of 19 April 1958 on Hainan Island. Both radioastronomical and optical observations were made. The latter included photoelectric and spectrographic studies. Figure 76–24 shows some of the equipment used in making these studies. In October 1958, a national solar research conference was held in Nanking. It was decided to concentrate on efforts for domestic production of a solar telescope of 60-centimeter aperture, accessory spectrographs, diffraction gratings, a white light coronagraph, and other needed instruments. The principal observatories adopted as their goal within three years the attainment of proficiency in forecasting short-period solar activity. These objectives have not been fully met, but some progress has been made in instrument construction and forecasting techniques. China considerably lags the leading nations of the world in facilities and competence in solar astronomy.

(3) *Radioastronomy* — Communist Chinese work in radioastronomy can be traced to the joint Sino-Soviet observation of the solar eclipse of 19 April 1958 on Hainan Island. The Soviet team used some portable radioastronomical equipment in their solar investigations. The Communist Chinese borrowed two of the Soviet radiotelescopes, approximately 8 to 15 feet in diameter, which they copied exactly, later returning the originals to the U.S.S.R. At a meeting in Peiping in July 1958, the Communist Chinese planned to establish a radioastronomical observatory near that city and later to set up radioastronomical sites at Nanking, Wu-han, and Canton. The founding group was composed of representatives of the Institute of Electronics (*Tien-tzu-hsueh Yen-chiu-so*), Peiping; the Peiping Astronomical Observatory; Peiping University; and Wuhan University. Considerable difficulty was experienced in finding qualified workers, but a start was made with the help of advanced students. Ch'en Fong-yung, who had participated in the Hainan expedition, was placed in charge of the first site, known as Peiping Radio-Astronomical Observatory, which is still under development. Research reported by the observatory has consisted of elementary solar investigations. The single known existing observatory lacks modern equipment, especially large interferometers and paraboloidal dishes, such as those available in the leading nations. A critical shortage of competent radioastronomers exists.

(4) *High altitude cosmic ray investigations* — Lo-hsueh High Mountain Laboratory, also known as the Mt. Lo-hsueh Cosmic Ray Observatory (*Lo-hsueh Kao-shan Shih-yen-shih*), Lo-hsueh, near T'ung-ch'uan, is the only known high altitude cosmic ray research facility on the Chinese mainland. The observatory has some U.S. and other foreign equipment for continuous observations and is conducting a research program to discover new particles in cosmic rays. Actually, little effort appears to be made to collate and analyze results of the observations. Work of the observatory is under the Institute of Physics (*Wu-li Yen-chiu-so*), AS, Peiping. Communist China has only a few competent cosmic ray physicists, and they are relatively inexperienced in primary cosmic ray work; however, considerable effort is being expended in training young scientists.

(5) *Ionospheric research* — Construction of a network of ionospheric vertical sounding stations in Communist China was reported by Radio Moscow in September 1959. The present number of stations and the extent of the network is unknown; however, Communist China reported six ionospheric stations in operation at the beginning of the IGY in 1957. It is probable that the equipment was imported from Hungary and/or East Germany, since the U.S.S.R. has obtained ionospheric sounding equipment from these countries. Communist China has conducted a small amount of ionospheric research for some time, with the principal work at Wu-han University, where an automatic recorder was planned, and at the Institute of Electronics. Other work has been reported at Zo Se Observatory, Canton, Chungking, and Lupin, Manchuria. A few competent ionospheric physicists, most of whom were trained in the United States, are available. Some Soviet bloc technical assistance has been given and a training program is underway. Progress can be expected in this area, which is of considerable significance in communications and space problems. (For related information, see also Section 71 of this NIS.)

c. SIGNIFICANT RESEARCH FACILITIES

Central Institute of Meteorological Research (Chung-yang Ch'i-hsiang Yen-chiu-so), Peiping—Director: Lu Wu. This institute is subordinate to the Central Meteorological Bureau (*Chung-yang Ch'i-hsiang Chu*). Approximately twenty-three stations of the Central Meteorological Bureau report visual aurora and airglow observations to the institute. Some cooperation may exist between the institute and the Institute of Geophysics and Meteorology in other aspects of upper atmosphere research. No important scientific accomplishments are known in this area.

Institute of Electronics (Tien-tzu-hsueh Yen-chiu-so), AS, Peiping—Director: Ku Te-huan. Subordinate to the Department of Technical Sciences, AS, this institute engages in ionospheric research and radar investigations of meteor showers. Involved in elementary electronic tracking of artificial earth satellites. Has cooperated with Peiping Astronomical Observatory and other facilities in building the radioastronomical observatory north of Peiping.

Institute of Geodesy and Cartography (Ts'e-liang Chih-t'u Yen-chiu-so), Wu-han Branch, AS, Wu-ch'ang—Director: unknown. This institute has a division of astronomical and geodetic surveying. Research tasks include development of methods and instruments used in applied astronomy and gravity determinations. The laboratory cooperates with the State Bureau of Geodesy and Cartography in studying problems of radio orientation surveying encountered in aerophotogrammetry and in taking gravity measurements.

Institute of Geophysics and Meteorology (Ti-ch'iu Wu-li Yen-chiu-so), AS, Peiping—Director: Chao Chiu-chang since 1946. The institute conducts research in meteorology, atmospheric physics, seismology, terrestrial magnetism, and applied geophysics. Much of the upper atmosphere research to date appears to have consisted of ozone observations, but the institute reportedly plans, in cooperation with the Institute of Mechanics, AS, to launch artificial earth satellites for research purposes by 1964 and a moon rocket by 1969. Important accomplishments of the institute have been in areas other than astronomy and upper atmosphere research.

K'un-ming Astronomical Observatory (K'un-ming T'ien-wen-ta'i), also known as the Feng-huang-shan (Phoenix Hill) Observatory, K'un-ming, Yunnan Province—Supervisor: probably Chen Chan-yun. Founded in 1939, this facility is subordinate to the Purple Mountain Observatory. In 1956, it was a small astronomical observation station with inadequate equipment, but it was scheduled for a considerable expansion of facilities within the next few years; current progress is not known.

Lo-hsueh High Mountain Laboratory (Lo-hsueh Kao-shan Shih-yen-shih), also known as the Lo-hsueh Cosmic Ray Observatory, Lo-hsueh, Yunnan Province—Director: unknown. Subordinate to the Institute of Physics of the AS, Peiping. This observatory, elevation 3,184 meters (10,444 feet), engages in high altitude cosmic ray observations. Its main objective is to discover new particles within cosmic rays. The observatory has multi-plate cloud chambers (U.S. made) and magnetic cloud chambers. It probably has neutron and meson monitors. Programs are directed by Drs. Chang Wen-yu, Hsiao Chien, and Wang Shan-yuan, competent cosmic ray physicists of the Institute of Physics (*Wu-li Yen-chiu-so*). No important accomplishments are known.

Peiping Astronomical Observatory (Pei-ching T'ien-wen-t'ai), Peiping—Director of the preparatory office: Cheng Mao-lan. This observatory is under construction and is scheduled for completion by 1962. It is intended to be much larger and more modern than the Purple Mountain Observatory. Plans call for a 2-meter reflecting telescope, a large Schmidt camera, a 40-centimeter twin astrograph, and a number of other instruments. The principal work of the observatory has been announced as stellar spectroscopy and photometry, but a comprehensive program is planned. Some solar research has been reported. The observatory is cooperating with the Institute of Electronics, Peiping, and other groups in building the Peiping Radio-Astronomical Observatory.

Peiping Planetarium, Peiping—Director: Chen Tsun-kuei. In addition to a Zeiss planetarium projector and two flanking pavilions for exhibition and lecture purposes, the planetarium is equipped with a Zeiss refractor and a few other instruments for research purposes. Opened on 29 September 1957 by the AS, the planetarium's most important contribution has been to popularize astronomy in Communist China. It has participated in the satellite tracking program.

Peiping Radio-Astronomical Observatory, ten miles north of Peiping—Director: Ch'en Fong-yung. This facility was founded in 1958 by a group representing the Institute of Electronics, the Peiping Astronomical Observatory, Peiping University, and Wu-han University. Reportedly, some buildings were completed in 1958. The observatory is thought to be poorly equipped with a few small radiotelescopes copied from Soviet equipment. There are plans for expansion of facilities; however, no radiotelescopes comparable to the larger Soviet or Western types are known to be planned or under construction. Personnel are not well trained in radio astronomy but are gaining experience, mostly in solar investigations. No important scientific accomplishments are known.

Purple Mountain Observatory (Tzu-chin-shan T'ien-wen-t'ai), Nanking—Director: Chang Yu-che. Deputy director: Sun Ke-ting. At present, this is the central astronomical observatory of Communist China; however, it will be supplanted in importance by the new Peiping Radio-Astronomical Observatory, which is now under construction. The observatory, located at an elevation of 267 meters (876 feet), is under the Department of Mathematics, Physics, and Chemistry, AS. The observatory is equipped with a 60-centimeter reflecting telescope, a 15-centimeter astrograph, a spectroheliOscope, and other instruments. Routine astronomical research is conducted, with the greatest emphasis on solar studies and photographic observations of comets and asteroids. The observatory also does other work in astrophysics, upper atmosphere research, chronometry, calculation of eclipses, and instrument construction. It has tracked and predicted the passage of artificial earth satellites. It directs the astronomical work of Zo Se and Zikawei Observatories in Shanghai, and the K'un-ming Observatory. It also maintains branches in Tsingtao, Tientsin, and Peiping. It is reported to have a large astronomical training program. Although facilities and personnel have been expanded considerably during the past several years, the observatory is still well below U.S. standards. Figure 76–25 shows the observatory and Figure 76–26 shows a reflecting telescope in use at this observatory.

Tientsin Latitude Station, near Tientsin—Director: unknown. This relatively new latitude station, founded in 1957 or 1958, is equipped with

Figure 76–26. Reflecting telescope at Purple Mountain Observatory

a 180-millimeter zenith telescope for latitude determinations. It is the only known station established specifically for latitude work in Communist China.

Wu-han Geophysical Observatory (Ti-ch'iu Kuan-hsiang-t'ai), AS, near Hankow—Director: unknown. Also known as the Institute of Upper Atmosphere Physics and subordinate to the Wuhan Branch, AS. Investigates physical properties of the ionosphere and effects on radio propagation; the relation of cosmic rays to other geophysical phenomena; and atmospheric chemical composition, including ozone studies. No important scientific contributions are known.

Figure 76–25. Purple Mountain Observatory, Nanking, 1959

Wu-han University (*Wu-han Ta-hsueh*), *Wu-ch'ang*—President: unknown. Conducts theoretical research and maintains a station for experimental investigations of the ionosphere. In mid-1958, a Soviet specialist visited the university to assist in establishing additional research facilities.

Zikawei Observatory (*Hsu-chia-hui T'ien-wen-t'ai*), *about 25 miles southwest of Shanghai*—Director: Li Heng. Zikawei Observatory, established in 1873, is one of the oldest permanent observatories on the Chinese mainland. The observatory engages in geophysical research, including geomagnetic work, under the Institute of Geophysics and Meteorology, AS. Astronomical work, under the Purple Mountain Observatory, includes routine solar and stellar observations, time service, and determinations of latitude and longitude. No important scientific accomplishments are known.

Zo Se Observatory (*She-shan T'ien-wen-t'ai*), *Shanghai*—Director: unknown. The Zo Se Observatory, AS, engages in routine astronomical and geophysical observations. In astronomy, solar observations are stressed and Faint Star Catalog work is done. Pertinent geophysical work includes vertical incidence ionospheric observations, determination of geomagnetic elements, and magnetic storm forecasting.

d. Outstanding personalities

CHANG Wen-yü (1728/2429/5940), Prof. Dr.—Cosmic rays and nuclear physics. Staff member, Institute of Physics, AS. A program director at Lo-hsueh High Mountain Laboratory. Research professor at Purdue University until 1956. Studied and taught at Yenching University. Received his doctorate in physics from Cambridge University. Has been a professor at National Szechwan University of Ch'eng-tu and at National Southwest Associated University. Also, professor at Princeton University. Research has concerned radioactive, nuclear disintegrations by high speed particles, interaction of mesons with matter, and cosmic rays. Has authored many scientific papers; "Analysis of Beta-disintegration Data," "Study of Showers Produced in Lead, Carbon, Beryllium," and "Further Results from the Study of Sea Level Penetrating Showers." Member of Physical and Philosophical Societies at Cambridge University and a member of the Chinese Physical Society. Born: 1910.

CHANG Yu-che (1728/6877/0772), Prof. Dr.—Astronomy. Director, Purple Mountain (Astronomical) Observatory. President, China Astronomical Society. Served as a member of the Chinese Communist National Committee for the IGY, and head of Working Group on Solar Activity for the IGY. Studied at National Tsinghua University and received his doctorate from the University of Chicago. Did postgraduate research at Yerkes Observatory and worked at Mt. Wilson Observatory. Professor at various Chinese universities. In 1953, visited the U.S.S.R. to study organization of Soviet scientific research. Member of the IAU, and of the IAU Commission for the Exchange of Astronomers, and headed the Chinese Delegation which attended the Ninth General Assembly of that organization, held in 1955 in Dublin. Has done considerable editing and translating, especially of Western astronomical terms and several books into Chinese. Member of the Science Society of China. Has been active in several astronomical organizations, including the Chinese Astronomical Society. Research studies have included; "A New Asteroid Observed at the Purple Mountain Observatory," "Photometric Observations of the Total Solar Eclipse of 30 June 1954 Made in the Caucasus," and "Photographic Observations of the Positions of Minor Planets at the Purple Mountain Observatory (1954)." Born: 1902.

CHAO Chiu-chang (6392/0046/4545), Dr.—Physics, geophysics, and meteorology, specializing in theoretical meteorology. Director, Institute of Geophysics and Meteorology, AS. Member (State) Scientific and Technological Commission. Member, Department of Biology and Earth Sciences, AS. Active in the work of the IGY; vice chairman of the Chinese National Committee for the IGY and served as head of Chinese delegation to the IGY Western Pacific Regional Conference at Tokyo. Educated in China and Germany. Has studied and lectured in the United States. In 1953, he was a member of the Chinese delegation which studied the organization of scientific research in the Soviet Union. Is active in Chinese Communist political organizations. Although probably now primarily concerned with scientific administration, actively encourages development of young meteorologists. Member, of the Compilation and Translation Committee, as well as the standing committee of the board of directors of the Chinese Meteorological Society. Past research includes the following: "The General Plan and Work of the Geophysics Research Institute," "Thermodynamics of Trade Wind Surface Circulation," "On the Stability of Zonal Circulation," and "Layer of Frictional Influence and Theory of Diurnal Wind Variations with Height." Born: 1907.

CH'EN Fang-yun—Electronics and radioastronomy. Head, Radio Division, Institute of Electronics. Director, Peiping Radio-Astronomical Observatory. Possibly working on adapting foreign techniques for electronic tracking of space vehicles.

CH'EN Tsung-ch'i (CH'EN, Parker C.) (7115/1350/0892)—For biographic information, see Subsection above entitled Terrestrial Geophysics and Geodesy.

CH'ENG Mao-lan (4453/5399/5695), Dr.—Astronomy and upper atmosphere research. Director, Preparatory Office for the Peiping Astronomical Observatory. Spent 32 years in France specializing in spectrophotometry of fixed stars and study of airglow and aurora. Returned to Communist China in 1957.

HSIAO Chien (5618/0256), Prof.—Cosmic ray physics. Staff member, Institute of Physics, AS, Peiping, and a program director, Mt. Lo-hsueh Cosmic Ray Observatory. Studied in California.

KUEI Chih-t'ing (KWEI, Paul) (2710/6347/1694), Dr.—Physics and upper atmosphere research. In charge of ionospheric station, Wu-han University. Also, professor of physics and dean of the College of Sciences at this university. Studied at National Tsinghua University and also in the United States at various universities. Taught at various Chinese universities. In early 1957, he was appointed head of the Working Group of Aurora and Airglow of the Chinese National Committee for the IGY. Has been a member of the editorial board of the Chinese physics journal. Member, American Physical Society, Chinese Society of Sciences and other organizations. Did work for the U.S. Government on nuclear development and measuring the stratosphere. Considered an excellent ionospheric physicist and is also interested in auroral phenomena. Born: 1895.

KUNG Shu-mu, Dr.—Astrophysics. Staff member, Purple Mountain Observatory, Nanking. Has studied at the University of California and the University of Michigan. Delegate to Pulkhovo convention, 1954. Has worked on the relation between solar flares and terrestrial phenomena, also on the quantum theory of the solar spectrum.

LI Heng (2621/3801), Dr.—Astronomy. Director, Zikawei Observatory. Formerly, director, Zo Se Observatory. Has been affiliated with the Purple Mountain Observatory. Head, Working Group on Longitudes and Latitudes of the Chinese National Committee for the IGY. Studied in China and did graduate work at the University of Lyon. Taught at West China Union University. In February 1957, he was one of two deputy heads of the Chinese delegation which attended the Western Pacific Regional Conference of the IGY. Member of editorial board of Chinese physics journal and of the Chinese astronomy journal. Reportedly, anti-Communist. Research has concerned the magnitudes, positions, proper motions and other aspects of galactic clusters. Has authored "Pattern of Red Stars," and "Photographic Studies of Five Galactic Clusters." Born: about 1900.

LU Pao-wei, Dr.—Radio engineering. A leading ionospheric specialist. Studied and did graduate work at the Massachusetts Institute of Technology and at Harvard University. Visited the U.S.S.R., Belgium, and Spain in 1956.

TAI Wen-sai, Prof.—Astronomy. Professor, Department of Mathematics and Astronomy, Nanking University. Introduced draft of 12 year plan for development of astronomy at the First Congress of the Chinese Astronomical Society.

WANG Kan-ch'ang (3769/3227/2490), Prof.—Cosmic ray physics and nuclear physics. Deputy director, Institute of Physics, AS. Has worked in nuclear physics in the U.S.S.R. Has studied in China, Germany and in the United States. Head, Working Group on Cosmic Rays of the Chinese Committee for the IGY in 1957. Taught at various Chinese universities. Has attended various international scientific meetings and conferences; and also attended the Moscow Conference on Peaceful Uses of Atomic Energy and the Conference on High Energy Nuclear Physics in Moscow. During 1956–57, is believed to have remained in Dubna in connection with his work for the Joint Institute for Nuclear Research, Dubna, U.S.S.R. Served on editorial committee for the *Chinese Journal of Physics*. Member, Chinese Physics Society. Worked under Dr. E. O. Lawrence and, reportedly, did research on cloud chambers with Dr. Lise Meitner. Wang's recent work has concerned the formation of heavy mesons and hyperons in cosmic rays, based upon the analysis of photographs obtained in a Wilson chamber. Wang, reportedly, designed the large bubble-type chamber for the synchrophasotron at Dubna. In 1956, he was said to have developed a radioactivity counter and radioactivity film detector. Has authored: "The Production and the Nuclear Capture of a K-Meson Observed in a Cloud Chamber"; "Electron-Proton Showers in Lead"; "A Suggestion on the Detection of the Neutrino"; and "Nuclear Field and Gravitational Field." Born: 1907.

C. Medical and veterinary sciences

1. Medicine

a. GENERAL

(1) *Capabilities and trends* — During the past several years, especially, the Communist Chinese have been making considerable progress in medical research. Research is, at present, intended to: 1) free the labor force in agriculture and industry from crippling transmissible diseases; 2) show the world that Communist China can equal and eventually overtake Western medical science; and 3) emphasize traditional Chinese medicine, both medically and politically. The most outstanding Communist Chinese medical research is on isolation of the trachoma virus, which has received international recognition. Other main trends in research include: parasitic diseases, especially schistosomiasis; virology, including Japanese B encephalitis, influenza, poliomyelitis virus survival, and the production of a vaccine against measles; and traditional Chinese medicine, and its potential in all medical fields. The study of the medicinal plants of China is actively pursued, including extensive research on their morphology and physiology, their chemical composition, and on the extraction and purification of their active principles. Successes are claimed with acupuncture and cautery, also called moxibustion (Chen Chiu therapy) in treating various kinds of illnesses. Much of the Communist Chinese research on infectious diseases is to raise the level of public health.

Under Soviet influence, Pavlovian concepts dominate physiologic research, and interesting results have been obtained in conditioned insulin secretion. Nervous tissue physiology and biochemistry are actively investigated. The use of radioisotopes in the exploration of various aspects of physiology and physiopathology is extensive.

Other creditable research includes work in biochemistry; the medical geography of China; industrial and occupational hygiene, especially work on silicosis and on dermatoses caused by lacquer; extensive burns; and synthesis of new drugs and new antibiotics, allegedly with antiviral and anticancer properties. Minor accomplishments are in hematology, surgery, and internal medicine.

A considerable amount of Communist China's medical research consists in repetition of work done abroad—often with slight technical modifications—and originality is often erroneously claimed. Tissue therapy, a therapeutic tool of doubtful value and not accepted by other European investigators, is a Soviet innovation that has found wide acceptance in medical practice in China. It has been used in pediatrics, ophthalmology, dermatology, and other specialties. Another Soviet technique which has been the basis of some Chinese clinical research is the use of Filatov-Kalifa's elastic tension curve in early diagnosis of glaucoma.

Soviet influence on scientific research in Communist China is great. There is close cooperation between Soviet and Chinese scientists; for example, a protocol on Sino-Soviet research was signed in Moscow in 1958, which outlined research on 122 major scientific and technical projects to be carried out jointly between 1958 and 1962. Separate cooperative agreements were signed simultaneously by the respective Academies of Sciences, the Ministries of Education, and the Academy of Agricultural Sciences. There is also cooperation at the working level with numerous Soviet scientists working in Chinese research institutes and acting as consultants on special projects. Reportedly, however, some of the best Chinese scientists are working in the U.S.S.R.

The meshing of political ideas and practices with research, which characterizes present trends and influences capabilities, has adversely affected the carrying out of research and the quality of results obtained. Required political indoctrination and political activities reduce the amount of time available for work. The shortages of facilities in medical schools, the shortening of curriculums, the reduction in the quality of medical education and, consequently, of the quality of graduates, have reduced the supply of trained personnel available for scientific research.

Research is also hampered by the assumption of administrative power by young Communists not qualified for their jobs and whose only claim to power lies in the orthodoxy and vigor of their political views. The teaching activities of the few qualified medical scientists also hinder research.

Lastly, the imposition of medical doctrines favored by political authorities for political reasons can have a crippling effect on good research. This is clearly seen in the effect of the Party's emphasis on traditional medicine as equal or superior to Western medicine. Considerable low quality research, emphasizing the value of traditional methods for the treating of a variety of diseases, has appeared in the literature in the few years following the adoption of the new Party policy toward ancient Chinese medicine. This leaning towards traditional methods is probably necessitated by the extreme shortage of personnel trained in modern medicine, who with their small numbers cannot hope to handle the health problems of 700 million Chinese.

Under the Communist regime, medical research, like all other types of research, has tended to be increasingly regimented. Medical research must be approved by state-controlled steering committees. Individual research is considered selfish, self-centered, and contrary to the best interests of the people, and is actively discouraged. Work is carried out instead by groups of scientists and technicians who are assigned projects and encouraged to work as a unit in competition with other units to which the same or similar projects have been assigned.

One feature of the state-controlled research organization is that the participation in research of all workers is encouraged, i.e., not only the scientific or medical and technical staff, but also other employees associated with the project. There is a determined effort to give particular emphasis, attention, and credit to achievements of the untrained workers associated with projects.

China has only 40,000 to 50,000 doctors trained in Western medicine, an estimated ratio of 1 to 13,000 people. Additionally, however, China has half a million traditionally trained healers who enjoy the trust and confidence of the population and considerable personal prestige. The government gives considerable support to traditional physicians, as reflected in training and other programs, and efforts are undertaken to ensure that their status is as high as that of Western-trained physicians.

Military and civilian establishments are cooperating closely in infectious disease research, medical radiology, blood transfusion, hemopathy, and other research applicable to defense against chemical, biological, and radiological warfare. An increased military interest in neurophysiology and psychology is indicated. An organization for psychology of national defense is to be established under the Ministry of National Defense in 1962.

(2) *Background and organization* — Chinese medicine has a long history, and important contributions to science have been made by traditional medicine. Chinese physicians were among the first to describe accurately some of the eruptive fevers, to treat cataracts by surgical methods, to understand the value of cowpox in the protection against smallpox, and to treat fractures under plaster of paris immobilization.

Anesthesia for completing painful procedures, probably containing *Cannabis indica,* Indian hemp, was first used under the Han dynasty (221–264 A.D.). A technique for the plastic repair of harelip was developed in 229–317 A.D. Smallpox was first described by Ko-Hung between 281 and 361 A.D. Jen Tsung (1023–1063 A.D.) recommended the use of powdered scabs from smallpox vesicles in the nose for protection, while the fleas of cows afflicted with cowpox were used in ground form for the prevention of smallpox. Wei-Yi-Lin in 1341 taught that broken vertebrae should be treated by traction and hyperextension of the spine, while many other Chinese surgeons already had discovered the advantages of fracture immobilization in plaster or clay poultices. During the Ming period, around 1682, Fu-Jen-Yiu used golden needles to couch cataracts, a method further developed by other traditional ophthalmologists.

A study of the background of medical research in China explains simultaneously the present handicaps and advantages that govern the work of medical researchers. The two greatest handicaps are the regimentation of research and the scarcity of well-trained personnel. The advantages result from the unlimited support given by the government to the projects in which it is interested. The regimentation is shown by the encouragement given to doctors to develop methods for complete cooperation in research for the prevention of certain major diseases.

In Shanghai, since 1958, some 239 research teams have been organized to cover 1,089 subjects, including schistosomiasis, tuberculosis, cancer, cardiovascular diseases, traditional medicine, and antibiotics. Members are drawn from scientific institutions, medical colleges, hospitals, local clinics, and health centers. All teams are urged to complete their special projects ahead of schedule.

It is claimed that the new method of research organization ends the isolation of different individuals and units working individually in particular fields, and also avoids duplication and lack of interchange of ideas. Research groups, working in coordination, can mobilize everybody concerned whenever difficult problems arise; however, Chinese medical scientists have not accepted this regimentation without some criticism, resentment, and struggle.

Traditional medicine continues to play an important part in Chinese life. Traditional physicians of established reputation are now admitted to the Chinese Medical Association (*Chung-hua I-hsueh-hui*), Peiping, on an equal basis with Western-trained doctors. One traditional physician is a vice president of the association. The number of "colleges" of traditional medicine has been increased from 4 to 15. A total of 20 institutes of traditional medicine have been established in the principal cities. Every hospital has a department of traditional medicine; 28,000 to 30,000 dispensaries offer traditional medicine treatment to the population throughout the country. Numerous courses in traditional medicine have been established for Western-trained physicians. This work of retraining Western physicians was initiated by the Ministry of Public Health (*Wei-sheng Pu*) in December 1955 under party directive and includes, besides part-time courses, a two-year course of full-time classes in the Research Institute of Chinese Traditional Medicine (*Chung-i Yen-chiu-yuan*), Peiping, also known as the Academy of Traditional Chinese Medicine, and Research Institute of Chinese Medicine. The curriculum includes the Communist Party's policy toward traditional medicine, dialectical materialism and fundamental theory of Chinese medicine, and clinical practice. These courses have been attended by more than 800 professors and other members of the staff of the Chinese Academy of Medical Sciences (*Chung-kuo I-hsueh K'o-hsueh-yuan*) since 1955.

This emphasis on Chinese traditional medicine affects the quality and the nature of research being carried out in China. Great numbers of personnel and facilities are being diverted to studies on traditional medicine, the majority of which are not conducted in accordance with accepted scientific concepts of good medical research. Furthermore, the best scientists are considered to be those trained in the West. However, these physicians are now, to a certain extent, being somewhat excluded, whereas other less well-trained physicians who are considered opportunistic and politically oriented are assuming control of the medical profession in China.

The scarcity of personnel is exemplified by the fact that there are no more than 150 to 200 scientists in China who have received adequate training for research, mostly in the United States. In addition, it is believed that there are no more than 4,000 to 5,000 qualified auxiliary personnel available to assist the small number of qualified medical scientists. The seriousness of this scarcity of trained personnel is accentuated by the fact that Communist China is only believed to have from 60 to 75 medical and pharmaceutical institutions doing research, from a total of 229 institutions of higher learning.

The formation of research projects and the organization of research on a national basis is the direct responsibility of the (State) Scientific and Technological Commission and is based on the Twelve Year Plan for Science (1956–67). Under this plan, the Ministry of Public Health has been assigned a five-year plan to expire in 1962, wherein research shall concern the five major parasitic diseases of China.

Medical and allied research is carried out under four different types of major organization: 1) the Chinese Academy of Sciences (*Chung-kuo*

K'o-hsueh-yuan), AS, Peiping; 2) the Chinese Academy of Medical Sciences (*Chung-kuo I-hsueh K'o-hsueh-yuan*); 3) Communist Chinese colleges and universities; and 4) the Academy of Military Medical Sciences (*Chun-shih I-hsueh K'o-hsueh-yuan*), of the Chinese People's Liberation Army, Shanghai. See FIGURE 76–27, which diagrams the organization of medical research in Communist China.

The most important research programs and the best facilities are those under the aegis of the AS. The AS comprises five departments, two of which play an important role in medical research: the Department of Mathematics, Physics and Chemistry; and the Department of Biology and Earth Sciences. The Department of Mathematics, Physics, and Chemistry oversees 11 research centers. Of these, the Institute of Applied Physics, now the Institute of Physics (*Wu-li Yen-chiu-so*), Peiping, is doing some work on isotopes. The Institute of Chemistry (*Hua-hsueh Yen-chiu-so*), Peiping, does research on pharmacology. In addition, the Institute of Applied Chemistry (*Ying-yung Hua-hsueh Yen-chiu-so*), in Ch'ang-ch'un; the Institute of Organic Chemistry (*Yu-chi Hua-hsueh Yen-chiu-so*) in Shanghai; the Institute of Pharmacology—also, the Institute of Materia Medica (*Yao-wu Yen-chiu-so*), Shanghai—conduct research in related medical fields.

The Department of Biology and Earth Sciences comprises 20 research centers, some of which are concerned with research in medical and related fields. These include the Institute of Experimental Biology (*Shih-yen Sheng-wu Yen-chiu-*

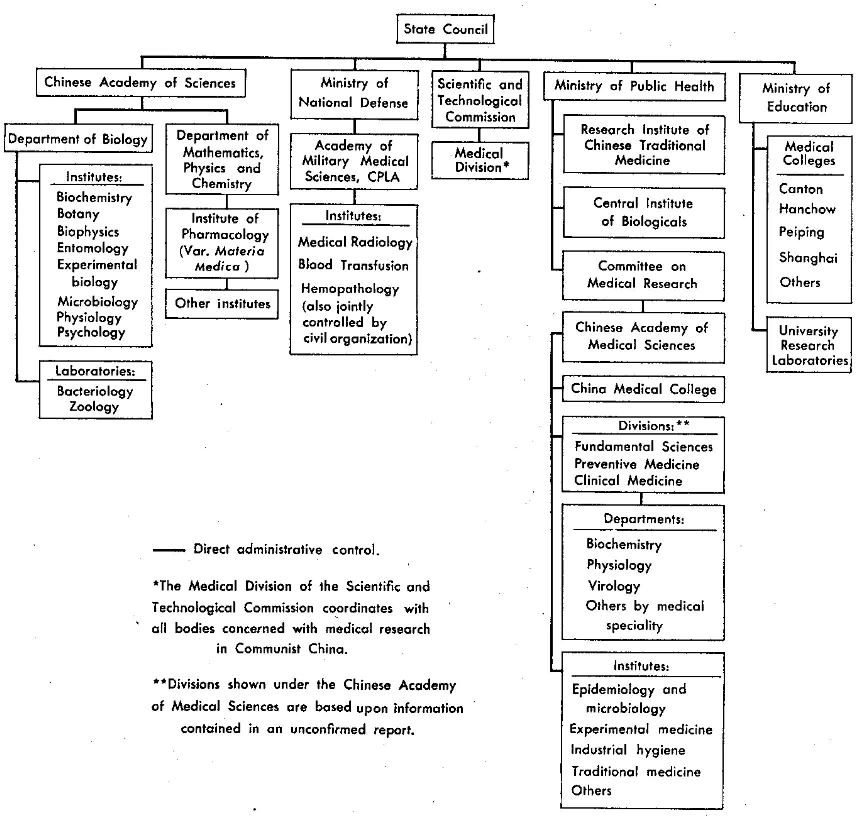

FIGURE 76–27. ORGANIZATION OF MEDICAL RESEARCH, COMMUNIST CHINA, 1960

[redacted]

so), Shanghai and Peiping; the Institute of Physiology (*Sheng-li Yen-chiu-so*) and the Institute of Biochemistry (*Sheng-wu Hua-hsueh Yen-chiu-so*), both in Shanghai; and the Institute of Entomology (*K'un-ch'ung Yen-chiu-so*), the Institute of Psychology (*Hsin-li Yen-chiu-so*), the Institute of Botany (*Chih-wu Yen-chiu-so*), and the Institute of Microbiology, formerly the Institute of Applied Mycology (*Wei-sheng-wu Yen-chiu-so*), all of which are located in Peiping; and Laboratories of Bacteriology in Peiping and Wu-han and a Laboratory of Zoology in Peiping.

The Chinese Academy of Medical Sciences, Peiping, was established by the Ministry of Public Health in 1957, after a reorganization of the Central (National) Institutes of Health, whereby facilities were consolidated and the staff was increased considerably from some 330 persons in 1956 to 2,500 researchers in 1957. Reportedly, this academy oversees some 10 departments concerned with medical research and other components in Peiping, Nanking, and Tientsin.

The laboratories are reported to be generally well-equipped, but very overcrowded, and the research, in general, seems to be of mediocre quality. An extensive building program is reported to be underway.

Reportedly, the Chinese Academy of Medical Sciences is composed of three main divisions which oversee work in the various medical and related fields. These divisions (Fundamental Sciences, Preventive Medicine, and Clinical Medicine) of the academy control a number of specialized departments, as well as institutes and laboratories distributed throughout the country. It is believed that the budget of this academy is very high, but no figures are available. The Chinese Academy of Medical Sciences is to have more autonomy in the future; although separate from the AS, it functions in cooperation with the latter organization.

Investigators apply for support to the particular department concerned, which then evaluates the application, and recommends or rejects the appropriation. Results of research with propaganda value are printed in *Scientia Sinica,* official organ of the Chinese Academy of Sciences, or in the *National Medical Journal,* organ of the Chinese Medical Association, which is a sizable publication with articles in Chinese and summaries in English. In addition, articles can appear in the *Chinese Medical Journal,* published mostly in English.

Medical research is also done in the laboratories of university professors. The significance of this work is almost impossible to assess. Chinese universities are not specifically intended for research but rather as teaching centers. Yet, a few projects are assigned to these laboratories as part of a wider scheme on specific subjects.

The main military establishment conducting medical research is the Academy of Military Medical Sciences of the Chinese People's Liberation Army (CPLA). This academy was established about 1951 in Shanghai under the Ministry of Defense. While it is primarily concerned with military medicine, its medical research establishments work closely with civilian research centers. Two medical research institutes under the joint control of this academy and civilian authorities are the Institute of Medical Radiology (*Fang-she I-hsueh Yen-chiu-so*) and the Institute of Blood Transfusion and Hemopathology (*Shu-hsueh Hsueh-i-ping-hsueh Yen-chiu-so*), Tientsin. Some medical aspects of military and civilian defense against nuclear, chemical, and biological warfare probably are investigated in military components of the Academy of Military Medical Sciences. Military personnel are also being assigned to civilian chemical and biological research installations.

b. MAJOR RESEARCH AND DEVELOPMENT BY FIELD

(1) *Parasitic diseases* — To raise the level of health and sanitation in Communist China, Chinese investigators have concentrated on the five major parasitic diseases of China: schistosomiasis, filariasis, malaria, hookworm disease, and kala azar. Conventional methods are being used in continuing epidemiological studies on malaria, kala azar, hookworm and other intestinal worms, with no new advances being reported.

(a) SCHISTOSOMIASIS — Intensive geographical research has been conducted to establish the exact distribution of the blood fluke *Schistosoma japonicum,* the cause of schistosomiasis, and of the intermediate snail host, *Oncomelania hupensis,* in China. Nationwide surveys showed that *Oncomelania hupensis* is widespread throughout China. Endemic regions of schistosomiasis fall into three categories: the canal region, the hilly region, and the lake and marshy region.

The most recent investigations on curative measures have centered on finding an antischistosoma drug which is less toxic than the tartar emetic (antimony potassium tartrate) now in common use. Other research on schistosomiasis includes injections of vitamin B_1 to alleviate nausea and other reactions due to tartar emetic; use of acupuncture to ease tartar emetic reaction; use of Chinese drugs to destroy the blood flukes; and the use of pumpkin seeds in the treatment and prevention of schistosomiasis.

(b) FILARIASIS — This disease, which was regarded as endemic only in places along the Yangtze River and in low-lying areas in Kwangtung, Fukien, Chekiang, and Hunan provinces, has now been found to occur also in the provinces of Hupeh, Kiangsi, Szechwan, Anhwei, Shangtung, Kwangsi, and Kweichow, and on Ho-nan Tao (Honan Island). The chief vectors of the bancroftian type are *Culex pipiens pallens,* north of the 30th parallel and *C. pipiens fatigans,* south of the 30th parallel. Malayan filariasis has been found to be transmitted through *Anopheles hyrcanus sinensis,* especially in the hilly regions of south China. It is claimed that large-scale clinical treatment has brought about complete recovery of 80% of some 3,600,000 patients. Chinese experiments show that the drug "Hai-chun-sheng" kills, not only the cercaria (final larval stage), but also the adult worms.

Chinese investigators have carried out experiments on dogs infected with *Dirofilaria immitis* and in man to clarify the problem of microfilarial nocturnal periodicity. Results indicate that the lung is the only organ in which the microfilariae are stored during the daytime, mostly in the lung capillaries. At night, during sleep, the microfilariae are released into the general circulation. Chinese investigators believe that this periodicity is directly under the control of the cerebral cortex.

(c) KALA AZAR — In recent years, Chinese investigators more precisely have been able to define the geographical distribution of canine leishmaniasis (infection with the parasite *Leishmani donovani*), which is a reservoir for human visceral leishmaniasis (also known as kala azar). It is present in the provinces of Chiang-hsi, Kansu, Shensi, Hopei, Honan, and Liaoning and is especially common in Kansu.

(2) *Bacterial diseases* — Acute bacillary dysentery always has been a problem in China. Research on bacillary dysentery has centered around the serological typing of domestic strains. Results show that *Shigella flexneri* and *Shigella sonnei* are the main groups found in China. Most of the strains of bacillary dysentery found in China have proved to be sensitive to sulfathiazole, dihydrostreptomycin, and chloramphenicol. Epidemic studies have revealed that the incidence of *Shigella* and *Salmonella* strains varies in different areas, and that their sensitivity to lysis by bacteriophage also varies.

A study of toxigenic dysentery in children has been made by Chinese scientists. Occurrence of toxigenic dysentery has been correlated with atrophy of the suprarenal gland. A toxic form which reportedly may kill a person within 24 hours has been given special attention. In addition, Chinese investigators have found that the isolation of typhoid, paratyphoid B, and dysentery phages by filtration methods could be substituted with advantage for other methods.

Noteworthy research also has been done by several Chinese hospitals on blood coagulation disorders in human leptospirosis which is also a major problem. The presence and severity of jaundice and the decrease of prothrombin activity, as well as the incidence of heparinemia, were found to be closely related. Vitamin K has been found to be useful in treatment of hemorrhage in leptospirosis patients.

(3) *Virus diseases* — Isolation of three strains of trachoma virus in 1957 by Dr. Tang Fei-fan (director, Central Institute of Biologicals to 1958) and associates is now receiving international recognition. The Communist Chinese isolations have been confirmed by British investigators. The main innovation of the Communist Chinese investigators, leading to isolation of the trachoma virus, was the use of streptomycin to control bacterial contamination in the egg culture of eye specimens. Until the discovery in 1957, trachoma was one of the few virus diseases, the causative organism of which was not available for study. Within two years, in 1959, as a result of this original accomplishment, several countries have been able to isolate and grow the formerly elusive trachoma virus in the laboratory. The original Communist Chinese discovery has been the basis for the recent development of a trachoma vaccine by scientists from the United States and Nationalist China working in cooperation in Taiwan. Results of these preliminary vaccine studies give promise of successful prevention and treatment of a disease which has been a cause of blindness among millions of human beings for centuries.

The Asian pandemic of influenza, which was believed to have originated in Kweichow Province in February 1957, has been studied in great detail. The causative virus was found to be a new variant of type A. A native live vaccine for Asian influenza virus, similar to the Soviet product, has been developed which, after intranasal inoculation, has been shown in field trials to provide an average reduction of morbidity of 50%.

Patterned after Soviet work, the Chinese claim that the multiplication of Japanese B encephalitis virus in chick embryos may make possible the use of such a system for providing a source of relatively pure virus particles, whereby a diagnostic antigen or inactivated vaccine could be prepared.

Poliomyelitis is one of the most important viral communicable diseases in China. Recent Chinese investigations on the epidemiology and virology of poliomyelitis have resulted in isolation of domestic strains of the virus. Reports from Chinese research work have indicated that a majority of the polio cases are type I. Treatment of polio in China has combined both Western methods of therapy and traditional Chinese medicine. Continuing investigations on polio in China include a serological survey of the Chinese population, attempts to develop early detection measures, and a national program for immunization with live polio vaccine.

Communist Chinese work on virus survival is concerned particularly with the effects of certain climatic conditions. The effect of relative humidity and temperature upon the virulence and endurance of airborne viruses has been studied. From these studies, Communist Chinese investigators have concluded that the relative humidity has a certain influence upon the virulence of the FM1 stock airborne influenza virus.

Chinese investigators have isolated adenoviruses, which were not known to have occurred in China. A survey has been made of the Coxsackie virus in Fukien province, where this agent has been found to prevail throughout the year.

At the end of 1958, a number of Chinese centers (Ch'ang-ch'un, Mukden, Peiping, Nanking, Shanghai, Ch'ang-sha, Canton) initiated investigations aimed at isolation of infectious hepatitis virus. It was reported that monkeys, especially the Rhesus monkey, seem more susceptible to infectious hepatitis than other animals.

(4) *Traditional Chinese medicine* — Considerable emphasis is placed on the value and potentialities of traditional Chinese medicine, which is being applied in various fields of medicine in China. This results in a great deal of Chinese research devoted to searching for new applications for Chinese herbs and for acupuncture and allied methods; thus, the value of the former is being explored in diabetes and that of the latter in peritonitis and many other conditions. The development of traditional medicine for political and other reasons has not yet yielded the expected dramatic results.

FIGURE 76–28. LECTURE ON ACUPUNCTURE AND CAUTERY FOR WESTERN-TRAINED PHYSICIANS AT SIAN MEDICAL COLLEGE, 1958

Traditional Chinese medicine includes a large variety of methods. Among the most important are treatment by acupuncture* and cautery, also called moxibustion (Chen Chiu therapy), as well as usage of more than 2,000 varieties of herbs—350 to 400 of which are in daily use. "Chen Chiu" is said to have been in use in China at the time of the Stone Age when "Paleo Chinese" invented the method. The theory on which it is based has been lost throughout the centuries. For political reasons, Chinese workers, utilizing modern medical research techniques, are attempting to rediscover the lost concept. As a result, the most active and original part of Chinese medical research is now oriented along these lines. FIGURE 76–28 shows a lecture being given for western trained physicians at Sian Medical College. Modern Chinese scientists have alledgedly improved acupunc-

* Essentially, the method consists of pushing a needle through one or more of the 700 points of the body (*Hsueh*) elaborately charted, with the hope of stimulating the activity of various tissues in the organs. This technique is intended to help the cure of the particular ailment. Numerous theories, some not necessarily of Chinese origin, have been propounded to explain scientifically the action of acupuncture. For example it has been stated by Japanese authors (a statement that has received audience in France) that possibly the way in which acupuncture worked was that it modified in a minute manner the electrical potential of the various cutaneous spots where the needles were introduced; from then on, along subtle nerve fibers chain reactions would ensue leading to different points of the organism. Changes in local metabolism would result from these electric changes which would be beneficial to the patient.

ture by allowing a low potential faradic current to pass through the needle. This is known as "electro acupuncture" and allegedly increases the stimulation, giving thus a combination of electric and mechanical acupuncture. It is claimed that, in some diseases, electro acupuncture gives better results than plain acupuncture.

X-ray diagnosis has been used to observe the results of traditional medicine therapy, and to understand the mechanism of its action and the effects of acupuncture on functional and physical changes on the gastrointestinal tract. Chinese researchers at the Peiping cancer institute used barium meals to study the changes in the esophagus of 13 normal patients under acupuncture. Acupuncture used at various definite points can, according to Chinese investigators, influence peristalsis throughout the digestive tract. Acupuncture at various points is claimed to alleviate the symptoms of radiation disease such as headache, dizziness, nausea, vomiting, and loss of appetite. It is also stated that the fall in the white cell count which follows intensive therapeutic irradiation can be relieved by acupuncture at certain points.

In addition to drugs recognized and used in the Western pharmacopeia, Chinese herbal medicines have been investigated for their possible use in therapy. Encephalitis, trachoma and other eye diseases, including cataract, are treated with Chinese traditional medicine and with acupuncture.

Considerable publicity has been given to the efforts of Chinese investigators to make a spectacular contribution in the field of cancer. The Communist Party has stated on many occasions that the answer to cancer could be found in some traditional Chinese drug, and has called for the exploration of this field for this purpose. Some publicity has been given to a new antibiotic, actinomycin K, said to have been discovered in 1957 from certain kinds of soil from China. Since 1957, there has been considerable investigation of this new antibiotic. More recently, it has been stated that eight Chinese drugs (unidentified) have been found to have anticancerous properties. In addition, acupuncture is said to be of considerable help as adjunct therapy.

In abdominal surgery, the only original contribution of Chinese workers is the treatment of acute appendicitis by traditional medicine. These investigators have reported that both herbal drugs and acupuncture treatment freed the patients of symptoms in 90% and 92.3% of the cases, respectively. Considerable emphasis also is on the treatment of hemorrhoids and anal fistulae with Chinese drugs.

Chinese investigators claim satisfactory results from the treatment of diabetes, hyperthyroidism, and tuberculosis with traditional Chinese therapy. Chinese investigators are trying to find a drug that would match *Rauwolfia serpentina's* action on hypertension. Further studies have been made on traditional Chinese drugs for the treatment of endocrine disorders, arthritis, stress, and nephritis.

(5) *Physiology of nerve, muscle, and tissue* — Chinese physiologists found much of their work on Pavlovian theories. A considerable variety of projects claim to be based on, and to explore further, the famous concept of the Russian scientist. There is scarcely any institution doing medical research that does not have at least one such project.

A rather substantial number of Chinese students have gone to the Soviet Union for training in the basic medical sciences with emphasis upon physiology. The purpose has been to pattern Chinese physiology according to Pavlovianism. Since the basis for substantial physiological experimentation was well established during the pre-Communist era, and under the pervading influence of Pavlovian concepts on Chinese physiology, conditioning techniques are studied and utilized by apt Chinese scientists.

Current Chinese electrophysiological work, which represents an extension of Pavlov's theories, includes microelectrode implantations and the recording of responses in the visual system. This work in electrophysiology is patterned after similar work in the United States and in the U.S.S.R. on behavior mechanisms.

In their studies on structure of brain cells, Communist Chinese investigators have established that the Purkinje cell in the cerebellar cortex begins its growth outside the nerve plexus. It was found to extend downward in a later period of growth, but to branch out because its downward movement is obstructed. Chinese investigators have also identified five additional brain cells similar to the Purkinje brain cell. Chinese scientists have found a variety of cerebellum mossy fibers, and have determined the origin of the mossy fibers, a question that had remained unsolved for nearly 60 years. Results of Chinese experiments indicate that the neuropil, a region of the nervous system consisting mainly of nerve-cell processes, is not an outgrowth of cells. Although the results showed that the neuropil comes into close contact with cells at its very end, no organic continuity was found between the cells and the neuropil. The nerve net theory is thus repudiated.

Communist Chinese research on Pavlov's conditioned reflex theory has clarified the effect of vestibular stimulation on the cerebral cortex and changes in the ordinary pattern of conditioned reflex. In experiments on the nerve reactions to external wounds, it was found that a certain chemical content of the brain of a rat increased when the rat was in shock. The damage was prevented from spreading to the nerve center by application of a tourniquet to the wound of the rat in shock. This result emphasized the importance of localizing the damage in shock prevention.

Communist Chinese experimentation on Pavlovian conditioned reflex theories also has established that a stimulant, when applied simultaneously to two or more organs, can produce reactions in the central system of the organs and can cause high blood pressure and accelerated respiration. It was also proved that histamine can produce, not only local reactions, but also a conditioned reflex which is subject to the control of the cerebral cortex.

The problems of nervous and connective tissues have been the subject of important studies in China. From bovine sciatic nerves, an electrophoretically homogenous albumin has been obtained which seems to be identical with serum albumin. The properties of the tissues of the central nervous system, the cortical responses to stimulations of the corpus callosum, and the electrophoretic behavior of some brain nucleoprotein are being explored. A comparative chemical study of the tropomyosins from different sources, especially from the terminal nerve structures, is being done.

Of interest are the Chinese conditioned reflex studies related to insulin secretion. Results indicate that sham feeding in dogs with esophageal fistulas causes measurable lowering of the blood sugar. Further experiments have been interpreted to mean that sham feeding reflexly leads to increased insulin secretion via the vagus.

Chinese scientists also have studied the influence of vitamin C on the adrenal cortex. Vitamin C deficient guinea pigs showed higher blood sugar, but lower liver glycogen content. ACTH fails to increase the glycogen content but gives an increase in fat and a decrease in nitrogen in the liver. After parenteral administration of glucose, the extent of rise of blood sugar was about the same as in the controls but that of the liver glycogen content was much less. Estimation of the liver phosphorylase activity failed to demonstrate any decrease to account for the deficient glycogen formation in ascorbic acid deficiency, but examination of the adrenal cortex revealed profound changes (enlargement of the cortex and hyperplasia of the fascicular zone. It was als found that extracts of certain tissues, such a liver, spleen, kidney, and muscle, were capable c stimulating the adrenal cortex, as judged by th ability to lower the ascorbic acid contents afte intraparenteral administration in albino rats.

A comprehensive review of pulmonary functio studies has been made recently to stimulate fu ther work along this line, which is extremel popular under the name of "breathing therapy in traditional Chinese medicine. Research has s far included the establishment of some of th Chinese norms in pneumophysiology, such as vita and maximum breathing capacity, residual vo ume, gas exchange by re-breathing tests, oxyge and carbon dioxide determination of arterial bloo and oxygen saturation. The application of know edge of pulmonary functions to industrial disease such as silicosis and others, is being stressed, bu little new data of international significance ai reported.

(6) *Radioisotopes in medicine* — Radiois topes have been used to test the toxicity of ant schistosomal drugs. Sodium thiophene sulfonat has been tested for its effects on reducing th toxicity of the antimony compounds used in th treatment of schistosomiasis. Other Chinese work ers used radioiodine (I^{131}) and radiosulfur (S^{35} to determine the mechanism of hemorrhages i radiation sickness. Chinese authors have als studied the effect of a half lethal dose of X-ray on rats to observe the changes in the permeabilit of the blood vessels during acute radiation sick ness. It was found that following irradiation th disappearance of the labeled serum from the ci culation appeared to be slow at first, more rapi later, and then gradually returned to norma Other workers investigating the effects of ioni ing radiation on blood formation found that th composition of the blood shows various degrees c change in radiation sickness.

Chinese scientists have also explored the rela tionship between the amount of phosphorous up take by the red blood cells and blood formatio Anemia was induced in rats by drawing blood fro the heart. Other Chinese investigators used S to observe the amino acid absorption by the cel and the egg yolk during the developmental stag of the chick embryo. Chinese scientists are e ploring the possibility of changing the antigen properties of the plasma with the hope of remo ing blood incompatibility in transfusions by e posing serum albumin to radiation.

Other studies involve the formation of protein i various organs followed by utilizing S^{35}-tagge amino acid. These studies so far have only co firmed results obtained in the United States and western Europe. The distribution of metallic ions in the organism has also been studied, using Zn^{65} as a tracer. Similar procedures were undertaken by other investigators to study the distribution of calcium ions and radioactive carbon, which confirmed results found in other countries. Using isotopes in diagnostic studies in clinical medicine, the main effort of Chinese researchers has been to establish whether Chinese norms in various areas are very different from other norms published elsewhere. Normal values have been established on healthy subjects in Peiping, Tientsin, Shanghai, Canton, Sian, and Shan-t'ou. Various clinical experiments are being carried out, especially at the Peiping Tumor Hospital, in connection with cobalt-60 teletherapy.

It is also stated that a cancer detector—type unspecified, but possibly including isotopes of phosphorus, iodine or sodium—has been discovered. Meanwhile, much is made of cobalt gun treatment of cancer in the anticancer centers of Peiping, Shanghai, Canton, and Wu-han.

(7) *Biochemistry* — During the past ten years, biochemistry in China has concerned the study of proteins, nucleic acids, enzymes, intermediary metabolism, vitamins, hormones, biochemistry of certain organs, and the biochemistry of certain microorganisms. The most important work probably is that related to proteins and enzymes, especially in the field of nerve physiology; however, the Chinese are not known to have done any really outstanding work.

In studies made on hemoglobin retrieved from the liver fluke, *Fasciola hepatica,* the hemoglobin was separated into globin and heme components, with recombination of heme with globin from beef blood. The reconstituted hemoglobin was identical in absorption spectrum and oxygen-combining capacity with beef hemoglobin, demonstrating the fact that the parasite and the host have the same heme component.

A protein not identical with any known muscle protein was demonstrated in skeletal, cardiac, and smooth muscle. Actinomycin K has been studied in an attempt to discover anticarcinogenic properties. It has been found to have the same amino acid composition and sequence as actinomycin D.

In enzymology, Chinese investigators essentially have been reproducing, with minor modifications, work done in other countries to align their techniques with those of more advanced investigators. A method was developed, making possible the systematic analysis of the condition, whereby two enzymatic systems compete for a common linking factor.

Various studies on cellular metabolism are also being made in China. Studies on amino acid metabolism are mainly centered on catabolic pathways from tryptophane to quinolinic or nicotinic acid. Chinese workers feel that they have demonstrated that such transformations are possible in rat liver slices, and also that more quinolinic and less nicotinic acid were produced in vitamin B_6-deficient slices and, further, that addition to such slices of pyridoxal phosphate brings the quinolinic production back to normal. It was concluded that quinolinic acid could not be an intermediate in the transformation of tryptophane to nicotinic acid.

Other investigations are on the effects of protein depletion and repletion on the activity of liver and lung. The activities of various enzymes decrease during protein depletion and increase during repletion at about the same rate as liver proteins. It seems that the animal body attempts to maintain the level of certain essential enzymes at all costs, giving greater adaptability to other more dispensable ones. The effect of riboflavin deficiency on protein metabolism has been studied by various investigators with no conclusive results.

Chinese scientists are investigating the physiology and biochemistry of *Streptomyces aureofaciens* in connection with aureomycin production. The factors studied include carbohydrate, oxygen consumption, organic acids, metallic ions, and phosphates. The effect of phosphates on aureomycin formation was either stimulatory or inhibitory, depending upon the composition of the medium, especially upon its carbohydrate content. Ultraviolet light treatment produced two interesting mutants, one of which exhibits poor growth and has very low invertase activity, while the other has high invertase with low aureomycin-synthesizing capacity. Mixing the two brings about good compensation in both growth and aureomycin increase.

Chinese biochemists have investigated problems related to foodstuffs and the nutrition of the Chinese people. The vitamin C content of foodstuffs of various localities has been studied, as well as the nutritive value of green tea. It has been confirmed that fermented bean products which are commonly eaten in China are a good source of riboflavin and vitamin B_{12}. The composition of cereals has received much attention. The content of methionine and lysine is lower in most cereal proteins as compared with animal proteins.

Various other researchers have explored the biochemistry of body fluids and tissues. Of possible interest is the discovery that fetal hemoglobin in the blood of Chinese children is higher than in foreign children; however, the highest rate is being found in anemic subjects.

(8) *Medical geography* — Chinese planners have explored the medical geography of China as part of the official governmental policy to raise the health and sanitation level of the people in order to ensure a strong, healthy labor force. An inventory has been made of the geographic distribution of diseases prevalent in Communist China (see the Subsection on parasitic diseases for related discussions).

Attempts are being made to determine the blood serological spectrum for the Chinese people. Surveys have already been made in Lan-chou, occupied Tibet, Shanghai, Peiping, and Tientsin by investigators from the Institute of Blood Transfusion and Hemopathology, Tientsin. Studies have been made on the geographic distribution of types A, B, O, M, and N. Between 0.4 and 1.9% Rh negative persons have been found in the various population samples studied.

Chinese scientists have investigated the intraocular pressure, the degree of protrusion of the eyeball, the pupillary diameter, the depth of the anterior chamber and the measurements of the bony orbits in samples of the various nationalities composing the Chinese population. Goiter research has consisted of investigations of iodine content of water, soil, and food in various parts of Shansi province, where most cases of goiter are found. Other studies involve the determination of urinary 17 ketosteroids and 17 hydroxycorticosteroids, as well as serum-protein-bound iodine in Chinese patients.

In the field of heart disease, Chinese workers emphasize that cardiac catheterization has become a standard preoperative examination in many medical colleges and city hospitals, and that heart surgery is on a par with that practiced in the West. Comparative epidemiological studies have been made to establish the relative morbidity of organic heart diseases. Surveys are being conducted in several districts to assess the prevalence of hypertensive heart diseases. It was found in Shanghai that 6.95% of the urban population had high blood pressure, while among the farmers, the rate was 1.95%. It was concluded that these rates were not too different from comparable rates prevailing in Europe and the United States. It was found that the relative incidence of arteriosclerosis is comparatively low—less than half of the rate observed abroad. It was also stated that the serum total cholesterol content of the Chinese is much lower than that of Europeans and Americans. Recent studies show that the incidence of the clinical manifestations of coronary atherosclerosis is rising in Shanghai, Peiping, and Tientsin.

Chinese workers have explored the etiology and epidemiology of the so-called "big joint" disease which is endemic in the northeastern and northwestern sections of the country. In certain areas, up to 30% of the people are affected. It is suggested that "big joint," the willow crutch of the northwest, Uroff's disease of the U.S.S.R., and Kashin-Beck (an endemic disease marked by shortness of the long bones with swelling of the joints) are actually the same disease. No special abnormality has been discovered in the water of the endemic areas. On account of the isolation of *Sporotrichiella* from food and water, Chinese workers favor the Soviet theory that these diseases are the result of intoxication by a dietary fungus.

(9) *Industrial medicine* — Following the work of Soviet scientists, Chinese investigators have stressed the study of silicosis (a generalized disease with characteristic fibrotic changes in the tissue of the lung), which is common among miners in South China. The nervous system often evidences dysfunction even before there is any X-ray evidence of the disease in the lungs. Chinese investigators have added their contribution to those of other workers in describing the nervous manifestations of this disease. They have particularly explored the sense of taste and the pain threshold in silicosis patients. Further observations have shown that patients with silicosis exhibit a lowering of the vegetative nervous functions measured by the reaction of the skin to ultraviolet radiation, dermograph (a condition in which the skin is peculiarly susceptible to irritation), water absorption tests, and oculo-cardiac reflex.

The successful treatment of a Shanghai steel-worker with over 80% of his body burned has beer extensively publicized by the Communist Chinese especially in view of the fact that burns of a: much as 50% are almost always fatal. Basi(treatment by blood transfusion, antibiotics, anc skin grafts was similar to that used in the Unitec States. Original measures of unknown effectiveness used by the Communist Chinese have included the use of blood from donors specially immunized against the patient's infection, and th application of bacteriophage, a virus which attacked the bacteria on the patient's skin. Success in this case by the Communist Chinese, wher others might have failed, was probably due t careful attention to detail, constant nursing, ingenious methods of feeding the patient, psychological support, and so forth.

(10) *Surgery* — In the various branches of surgery, the Chinese have essentially repeated methods and techniques that were well established in the Western world. Notable, however, are the studies made in induced hypothermia and controlled hypotension. Chinese workers have remarked that the patient should be hyperventilated before the occlusion of the circulation, and they use prostigmine or acetylcholine to induce cardiac arrest. The coronary arteries are perfused with fresh arterialized blood during the course of the circulatory occlusion.

Heart surgery seems to have a great attraction for Chinese workers, and in four or five of the most important surgical centers, especially Shanghai, heart surgeons trained in the West practice open heart surgery using Western-made apparatus, especially Swedish. The first operation for interventricular septal defect is said to have been performed in Shanghai in late 1959. Nine such operations are said to have been done in the country. Western visitors assert, however, that there are considerable gaps in knowledge and in the personnel needed to do advanced research along this line. There seems to be no doubt that the Chinese desire to do open heart surgery is an attempt to keep China abreast of the West in all possible branches of medicine.

In order to obviate certain syndromes, including portal hypertension, Chinese authors are making much of the venous shunting operation which is very seldom performed in the West.

(11) *Military medicine* — Projects underway in the field of radiological research of military significance include studies on protection against radiation injuries, detection of harmful radiation dosages, determination of harmful radiation levels, and treatment of radiation sickness. Most work in this field is patterned after Soviet research, and few Chinese papers have been published to date. Reportedly, radiological research is making rapid progress in Inner Mongolia, where installations also have been established.

Much of the civilian microbiological and infectious disease research is of military interest, such as research on pathogenic bacteria. In 1951, plague research at the Pai-chia Special Disease Research Institute, Pai-chia, was under the direction of a Soviet plague expert. Here, also, Japanese as well as Soviet experts were studying bubonic plague, typhoid fever, and cholera.

Other civilian research of military interest is on insect vectors of disease, and on microbial genetics at the Dairen Institute of Biologicals, under the control of the Ministry of Public Health. The Central Institute of Biologicals (*Chung-yang Sheng-wu Chih-p'in Yen-chiu-so*), Peiping, conducts biologic research which has military application, and produces vaccines, serums, and antibiotics. Military research teams have been cooperating with civilian investigators to find a new anti-schistosoma drug.

Basic physiological research on the effect of positive pressure breathing on interoceptive reflexes is being carried out at the Academy of Military Medical Sciences (*Chun-shih I-hsueh K'o-hsueh-yuan*), of the CPLA, Shanghai. Current military interest in psychology and neurophysiology is indicated in the proposed establishment of an Organization for the Psychology of National Defense in the Chinese People's Liberation Army by 1962.

c. Significant research facilities

Academy of Military Medical Sciences (*Chun-shih I-hsueh K'o-hsueh-yuan*), *Shanghai*—Commandant: Chien Hsin-chung (October 1958). The academy was established in 1951 and is subordinate to the CPLA of the Ministry of National Defense. It has departments for biochemistry, nutrition, parasitology, pharmacology, and physiology. In cooperation with the Institute of Materia Medica, AS, the academy is attempting to discover a better anti-schistosomiasis drug. Research on organophosphorus compounds for insecticides gives the academy chemical warfare potential. Physiology research includes: effect of positive pressure breathing on interoceptive reflexes; suppressive effect of eating on the motility of an empty stomach; change of the secretory function and motility of a stomach as a result of activities of the higher central nervous system. Neuropsychiatric research includes: conditioned reflex of speech accentuation; regulation of speech by the activities of the cerebral cortex; reaction of respiratory movements of blood vessels in psychiatric patients; and epilepsy.

China Union Medical College (*Chung-kuo Hsieh-ho I-hsueh-yuan*), *Peiping*—President: Li Tsung-en (purged as a rightist in March 1958). This is the leading medical college in Communist China. Formerly, was known as the Peiping Union Medical College, and was sponsored by the Rockefeller Foundation. It was taken over by the Communists in January 1951, when its name was changed to the China Union Medical College. It was subordinated to the Ministry of Public Health, and its courses were reserved for graduate work only. In 1958, it became affiliated with the Academy of Medical Sciences and, in August 1959, its name was changed again to the China Medical College. The curriculum was reorganized into an eight-year course, and it was reopened in September 1959. Because of the heavy teaching workload imposed upon the faculty, little research is being accomplished. Current experiments in Pavlovian physiology include: the building of an automatic time controller for conditioned reflex experiments, and the study of the stomach secretory conditioned reflex by histamine.

Department of Virology, AMS, Peiping—Director: Huang Chen-hsiang (March 1958). This department may already have achieved institute status. Particular research effort has concerned the study of influenza virus and Japanese B encephalitis, and experimentation to develop a vaccine for the latter disease. Work to develop a polio vaccine has involved the use of the human rather than monkey amnion, which has proved to be much cheaper.

Institute of Biochemistry (Sheng-wu Hua-hsueh Yen-chiu-so), Shanghai—Director: Wang Ying-lai (January 1959). This institute, subordinate to the Department of Biology, AS, was formerly part of the Institute of Physiology and Biochemistry, which was divided in early 1958. Research centers on proteins, enzymes, nucleic acid, and vitamins. There is continuing interest in the structure and function of proteins, biological composition and metabolism, and biosynthesis, with particular emphasis on study of physicochemical properties in the nervous system and connective tissues, e.g., the effect of sound on the cerebral proteins of mice. Enzyme research consists of study on the respiratory enzymes, especially the cytochromes, enzyme separation, the mechanism of enzymic action, dyhydrogenases containing flavines, and liver amino acid oxidases. Nucleic acid research continues on the metabolism of nucleotides and nucleosides. Biosynthesis of vitamins C and E and riboflavin in animal tissues are studied, with particular emphasis on the enzyme systems involved.

Institute of Biophysics (Sheng-wu Wu-li Yen-chiu-so), Peiping—Director: Pei Shih-chang (July 1959). This institute is apparently recently established and is subordinate to the Department of Biology of the AS. This facility may very well be identical with the Peiping Institute of Experimental Biology. Pei Shih-chang is listed as director for both. Research efforts are very similar at both reported institutes. Work on embryology concerns the effect of nucleic acid on the embryological development of amphibians, birds, and silkworm moths; in the biophysical field, studies are on the effect of X-rays on the blood and male germ cells of the Rhesus monkey.

Institute of Epidemiology and Microbiology (Liu-hsing-ping-hsueh Yu Wei-sheng-wu-hsueh Yen-chiu-so), Peiping—Director: Chen Wen-kuei (July 1959). This institute is subordinate to the Academy of Medical Sciences. Research is being conducted on various methods for chemotherap of tuberculosis, such as native drugs, and on meta compounds of mercaptobenzothiazole. In th field of oncology, it has been discovered that dis coordination of activities of the higher centra nervous system can induce tumors.

Institute of Experimental Biology (Shih-ye Sheng-wu Yen-chiu-so), Shanghai—Directo Chu Hsi (October 1959). This institute is subor dinate to the Department of Biology, AS, and ha laboratories for developmental or embryo-physiol ogy (headed by Chuang Hsaio-hui) and experi mental oncology (headed by Yao Hsin). It als has a branch institute in Peiping—the Peipin Institute of Experimental Biology, which was es tablished in September 1957 from an existin work station with Pei Shih-chang, former direc tor of the Shanghai institute, as its director; how ever, the latter institute is now believed to b the Institute of Biophysics. Principal researc is in the fields of: embryology, such as the rela tionship between the start of typical differentia tion in different organs and the conditions (re generation and chemical embryology); and on cology, such as the effect of cancerous substance (methycholanthrene) on the appearance of tu mors in tailless amphibians and on the process o morphogenesis; effect of native medicine remedie on tumors transplanted and inoculated to an mals from man; effect of native medicine remedie on the growth of carcinoma cultures; and stud of biochemical processes of tumors by radioactiv tracers. The institute also studies the healing o wounds and the regeneration of muscles.

Institute of Experimental Medicine, Peiping– Director unknown. This institute is subordinat to the Academy of Medical Sciences, and has de partments of biochemistry, experimental mo phology, pathology and physiology. Oncolog seems to be the main area of research, with stud ies on the seratherapy of tumors and the success ful culture of human cancers in mice for severa generations (fibrosarcoma, 3; fibroneurosa coma, 11; and chondrosarcoma, 4). The institut also studies the use of anticholinergic drugs i the cure of ulcers, and the reflex action of hista mine on blood pressure and gastric secretion.

Institute of Labor Hygiene, Labor Protectio and Occupational Diseases (Lao-tung Wei-shen Lao Tung Pao-hu Yu Chih-yeh-ping Yen-chiu-so Peiping—Director: Shi Chung-chang (acting a of November 1957). Also known as the Institut of Industrial Hygiene. This institute is subord nate to the Academy of Medical Sciences and ha six departments: toxicology, air conditioning an ventilation, dust detection, dust physiology, e vironmental physiology and industrial diseases. It also has a branch in Tientsin.

Institute of Materia Medica (Yao-wu Yen-chiu-so), Shanghai—Director: Chao Cheng-chia, also known as Chao Cheng-ku (September 1960). This institute, also called the Institute for Pharmacology and/or the Institute of Pharmaceutical Chemistry, was established in 1950 and is subordinate to the Department of Mathematics, Physics, and Chemistry, AS. It has three departments: antibiotics, pharmacology and pharmaceutical chemistry. In conjunction with the Academy of Military Medical Sciences, the institute is trying to develop a new drug for schistosomiasis which would be more efficacious and less toxic than the traditional tartar emetic remedy. Continued antibiotics research has produced a new antibiotic, actinomycin K, which is reported to be a cancer inhibitor. Herbal medicine investigations continue, with particular emphasis on native drugs to treat hypertension.

Institute of Physiology (Sheng-li Yen-chiu-so), Shanghai—Director: Feng Te-p'ei (April 1958). Formerly, part of the Institute of Physiology and Biochemistry, which was divided in early 1958, this institute is still subordinate to the Department of Biology, AS. It has departments of neurophysiology and neurohistology. Current research problems are on the electric potentials of the cortex, the symmetrical activities of the cerebral hemispheres, and the neurohumoral secretion of the stomach.

Institute of Psychology (Hsin-li Yen-chiu-so), Peiping—Director: P'an Shu (February 1958). The former AS Laboratory of Psychology was combined with the Nanking University Psychology Department on 29 December 1956 to create the present institute, which is subordinate to the Department of Biology of the AS. It has departments of: aviation psychology (headed by Tsao Jih-chang); industrial psychology (headed by Li Chia-chih), clinical psychology (scheduled to move to the Academy of Medical Sciences by 1962), personality, sensation and perception, and thought and languages (headed by Wu Chiang-lin). Branches of the institute are to be established in Kirin, Sinkiang, and Yünnan provinces by 1962. In cooperation with Peiping Medical College, the institute has successfully treated neurasthenia with combined medical-psychological treatments.

National Vaccine and Serum Institute (Chung-yang Sheng-wu Chih-p'in Yen-chiu-so), Peiping—Director: Li Chih-chung (October 1959); Tang Fei-fan (1950–58). It is also known as the Central Institute of Biologicals. It is believed to be subordinate to the Ministry of Public Health; however, this institute may now be under the jurisdiction of the AMS, inasmuch as a December 1959 listing of that academy's institutes includes an Institute of Biologicals. The central institute has branch institutes located in Ch'ang-ch'un, Dairen, Hankow, K'un-ming, Shanghai, and Wu-han. FIGURE 76–29 shows the K'un-ming branch of this institute. Particular research is in the lyophilization of live vaccines and work on vaccines against polio, influenza, Japanese B encephalitis, and yellow fever. It also studies serum proteins, the formation of diphtheroid toxins, and the nutrition of bacteriophages. The institute itself produces vaccines for brucellosis, cholera, typhoid and paratyphoid, tetanus toxoid, typhus, plague and pertussis, as well as gamma globulin and BCG for tuberculosis.

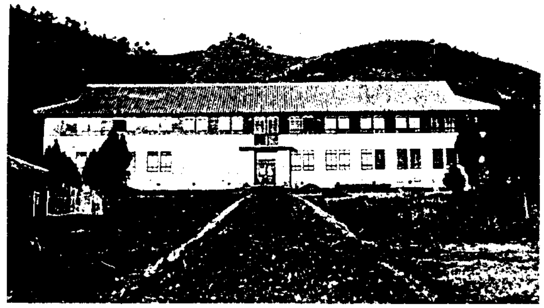

FIGURE 76–29. BRANCH OF THE NATIONAL VACCINE AND SERUM INSTITUTE, K'UN-MING

Peiping Medical College (Pei-ching Hsieh-ho I-hsueh-yuan), Peiping—President: Hu Chuan Kuei (November 1955). The medical college was founded in 1912 as a part of Peiping University, but became independent in 1953 and subordinate to the Ministry of Public Health. There are departments of medicine, pharmacology, stomatology, and public health. The college also controls four hospitals and a pharmaceutical factory. There is a heavy emphasis on Pavlovian physiology in research and some interest in nutritional problems. A new coordinated medical-psychological treatment for neurasthenia has been developed, in cooperation with the Institute of Psychology, AS. Specific research projects include: problems of blood preservation and transfusion; influence of suffocation on liver function and of pneumonectomy on renal functions; changes of renal functions after injection of agents stimulating to the brain, and to the ureters and renal pelvis; change of gaseous content in the blood after arterial or venous transfusion following loss of blood; observation of change of lactic acid and glucose in the blood after injection of different agents stimulating to the brain; relation between hypothyroidism and liver function; and effect of concussion of brain on shock.

Research Institute of Chinese Traditional Medicine (*Chung-i Yen-chiu-yuan*), *Peiping*—President: Lu Chih-chun (May 1957). This institute was reorganized on 19 February 1956 from an institute which had been established under the Ministry of Public Health in 1950. It is still subordinate to the ministry, and appears to have taken over the traditional medicine section of the Academy of Medical Sciences as well. There is also a Peiping Institute of Traditional Medicine, which consists of a medical college as well as a hospital, both of which are probably affiliated with the research institute. This institute has departments of acupuncture and moxibustion (headed by Chu Lien), internal medicine, surgery and traditional drugs. Typically, the research is directed towards the study of medicinal herbs and the theories of Chinese traditional medicine. More specifically, studies are conducted on the edema of cirrhosis, hypertension, cancer of the cervix uteri, and poliomyelitis.

d. Outstanding personalities

CHANG Hsi-chun (1728/6932/6874), Dr.—Physiology, specializing in endocrinology and acetylcholine research. Professor, Department of Physiology, Institute of Experimental Medicine, AMS, since 1957. Head of the Department of Physiology, China Union Medical College, 1950–56. Member: Department of Biology and Earth Sciences, AS. Served on the Health Publicity Planning Committee, All-China Association for the Dissemination of Scientific Knowledge, in 1953. Educated in the United States, the United Kingdom, and Switzerland. Has visited the U.S.S.R. and has attended scientific conferences in Germany (1954), Belgium (1956), and Finland (1957). Although sometimes described as politically disinterested, he is friendly to the Communist regime. Research has concerned physiological studies based upon concepts of Pavlovian conditioned reflex. Born: 1899.

CHANG Wei-shen (1728/3634/3947), Dr.—Antibiotics. Director, Institute of Antibiotics, AMS, since 1958. Staff member and director, Antibiotics Laboratory, National Vaccine and Serum Institute (also known as Central Institute of Biologicals), 1952–57. Served on National Antibiotics Research Commission in 1956. Received graduate education in the United States. Attended antibiotics symposia in Poland in 1955, and Czechoslovakia in 1959. Speaks English and has reading knowledge of French and German. Member: Communist Party of China. Research: development of antibiotics for treatment of plant pathogens and antitumor substances, and production of penicillin. Co-author of: "The Production of Penicillin with Penicillin Chrysogenum Strain U-49 III." Born: 1909.

CHAO Ch'eng-chia (CHAO Ch'eng-ku) (6392/2110/0858), Dr.—Pharmaceutical chemistry; an outstanding Chinese pharmacologist. Director, Institute of Materia Medica, AS, since about 1950. Member: Department of Physics, Mathematics, and Chemistry, AS. Educated in France and Switzerland, and worked in Paris for eight years. Research: physiological effects of the essential components of Chinese herbal drugs, and drugs for schistosomiasis, high blood-pressure, and the nervous system. Has published numerous papers on herbs and pharmaceuticals. Born: about 1890.

CHAO I-ping, Dr.—Physiology; one of China's leading physiologists. Head, Division of Animal and Human Physiology, Peiping University, since 1953. Professor, China Medical College, in 1953. Member of Biology Department, Tsinghua University, 1949–51. Chairman (1953) and vice chairman (1957 and 1958), China Physiology Society. Member: Scientific Committee, Institute of Psychology, AS. Received his education in the United States. Delegate to the Eighth Congress of Physiologists, Biochemists and Pharmacologists, Kiev, U.S.S.R., in June 1955. Speaks English and some German. Recent research: study of the physiology of the higher central nervous system, and study of the physiology of workmen under all conditions. Born: 1909.

CHEN Wen-kuei (7115/2429/6311), Dr.—Bacteriology. Specializes in production of serums and vaccines. Director, Institute of Epidemiology and Microbiology, Academy of Medical Sciences, since at least 1957. Chief of Medical Services, Chinese People's Volunteers in Korea, in 1952. Member, Department of Biology and Earth Sciences, AS, in 1955. Vice chairman, board of directors, China Medical Association. Served on the International Scientific Commission which investigated alleged use of bacterial warfare by U.S. forces in Korea and Northeast China (see also Section 74 of this NIS). Speaks English very well. Educated in United States during the 1930's, and has traveled extensively to attend political and professional conferences. Foreign travel during the 1950's includes visits to Budapest, Vienna, Korea, Poland, and the U.S.S.R. Research: plague prevention and epidemiology. Born: 1897.

CHUNG Hui-lan, Dr.—Tropical medicine and parasitology; professionally capable and a good teacher. Superintendent of the Central People's Hospital of Peiping, since at least 1954 and as of 1958. Clinical professor of medicine at both the China Union Medical College and at the Peiping Medical College in the early 1950's. Member: Department of Biology and Earth Sciences, AS; China Medical Association (vice president since 1953). Served on the Commission for Medical Research, Ministry of Public Health, in 1955; on the Health Publicity Planning Committee, All-China Association for the Dissemination of Scientific Knowledge, in 1953; and on the Committee for Interflow of Knowledge of Native and Western Medicine, China Medical Association, in 1953. Educated in the United States, the United Kingdom, and Germany, he has attended professional conferences in Pakistan, Austria, Rumania and the U.S.S.R. Extremely fluent in English. Research: parasitology, especially kala azar, schistosomiasis and leptospirosis. Born: about 1901.

FANG Hsin-fang—Microbiology; one of the leading antibiotics authorities in Communist China. Director, Institute of Microbiology, AS, since 1953. Served on the Scientific Committee of the Institute of Applied Mycology (now the Institute of Microbiology), in 1956. Attended First Regional Conference on Electron Microscopy in Japan, October 1956. In 1958 visited Poland at the invitation of the Polish Academy of Sciences. Research: preparation of antibiotics, and research on aureomycin.

FENG Lan-chou, Dr.—Parasitology; described as the best parasitologist in China. Faculty member, Department of Parasitology, China Union Medical College (formerly Peiping Union Medical College), since 1929 (chairman of this department since 1952). Researcher, Institute of Entomology, AS, since at least 1956. Researcher, Institute of Parasitic Diseases, Academy of Medical Sciences, in 1960. Member: preparatory committee, First All-China Scientists Conference; board of directors, Entomological Society of China; vice chairman, Microbiological Society of China. Served on International Scientific Commission for the Investigation of the Facts Concerning Bacterial Warfare in China and Korea, 1952. Awarded first national scholarship for science by the AS for work on control of malaria and filariasis. Educated in the United Kingdom. Research: control of malaria and filariasis. Born: 1903.

FENG Te-p'ei (7458/1795/1014), Dr.—Biophysics; an excellent instructor and one of the best research physiologists in Communist China. Director, Institute of Physiology, AS, since 1958. Director, Institute of Physiology and Biochemistry, AS, 1952–58. Member: Department of Biology and Earth Sciences, AS. Received science award from Chung-hua Cultural Foundation in 1935. Has served on numerous scientific committees and has been a delegate to various international scientific meetings. Before advent of the Communist regime, studied and conducted research in the United States, the United Kingdom, and Germany. Has an excellent educational background and reportedly has been the student of four Nobel Prize winners. Since 1949, has visited the U.S.S.R. in 1949, 1953, 1957, and 1958. Has also made scientific visits to Tokyo (1955), Brussels (1956), and Geneva (1956). Speaks excellent English. Is considered an enthusiastic Communist. Research: peripheral nervous system, particularly skeletal neuromuscular transmission, and the central nervous system. He is not known to have published any scientific papers since 1951, when he co-authored "The Relief of the Cocaine Block in Nerves by Anodal Current." Born: 1907.

HUANG Chen-hsiang, Dr.—Virology; brilliant virologist, well-trained and very conscientious. Director, Department of Virology, Academy of Medical Sciences, since 1945. Served on National Health Research Committee in 1955. Member of the International Scientific Commission for the Investigation of Facts Concerning BW in China and Korea, 1952. Studied and did research in the United States. Has frequently visited Czechoslovakia (three times in 1957 alone). Research: neurotropic viruses, such as St. Louis encephalitis, Eastern equine encephalitis and Columbia SK, as well as viral and rickettsial diseases and bacterial and parasitic diseases. For information on his publications, see SECTION 74 of this NIS. Born: about 1907.

HUANG Chia-ssu (7806/1367/7475), Dr.—Thoracic surgery; a distinguished physician. President, Academy of Medical Sciences, since 1958. Member, Commission for Medical Research in the Ministry of Public Health. Vice president, Shanghai First Medical College (formerly Shanghai Medical College), from at least 1952 to 1958. Member: Department of Biology and Earth Sciences, AS; Communist Party of China. President, China Medical Association. Served on National Health Research Committee in 1955, and with Shanghai sub-unit of International Medical Prevention Unit during Korean war. Received some graduate education in the United States. Has visited the U.S.S.R. in 1955, 1956, and 1957. Made political visit to Vienna in 1952, and attended International Congress of Doctors for the Study of Present Living Conditions, Vienna, in 1953. Spent six months in Korea in 1951. Reads, speaks, and writes English and German. Research: pulmonary resection for tuberculosis. Born: 1907.

HUANG Ming-hsin, Dr.—Internal medicine; well-known specialist in his field. Researcher, Department of Medicine, Shanghai Second Medical College, since at least 1955. Dean, St. John's Medical College, from 1946 to at least 1950. Member: Department of Biology and Earth Sciences, AS. Served with International Medical Prevention Unit during Korean war. Educated in the United States. Visited Korea in 1952, and attended Rumanian Congress of Medical Workers in 1957. Research: cardiovascular diseases and cardiac surgery for patients suffering from mitral stenosis, fibrillation, rheumatic heart disease, and right ventricular failure; cardiographs for diagnosing heart diseases; schistosomiasis and rheumatism.

PEI Shih-chang (6296/2514/3864), Dr.—Biology; excellent scientist in both general concepts and experimental research. Director, Institute of Biophysics (formerly Institute of Experimental Biology, AS, Peiping), AS, since 1957. Director, Institute of Experimental Biology, AS, Shanghai, from 1949–57. Faculty member, Chekiang University, from 1941 until at least 1953 (chairman of Department of Biology, 1950–53). Appointed to Secretariat, AS, 1954. Member: Department of Biology and Earth Sciences, AS. Served on International Scientific Commission for the Investigation of the Facts Concerning Bacterial Warfare in Korea, 1952; and on Science Scholarship Committee, AS, in 1955. Educated in Germany, and has visited the U.S.S.R. in 1953 and 1957. Fluent in German, English, and French. Research: hormones, experimental embryology, experimental morphology, and physiology. Born: about 1899.

T'ANG Fei-fan (3282/7378/0416), Dr.—Microbiology; an extremely capable scientist. Director, National Vaccine and Serum Institute (also known as the Central Institute Biologicals), 1938–59. Member: Department of Biology, AS; and National Antibiotic Research Work Committee. Chief director, China Microbiological Society. Served on National Health Research Committee in 1955, and on International Scientific Commission for the Investigation of Facts Concerning Bacteriological Warfare in Korea and China, in 1952. Educated in the United States, and carried on research in the United States and the United Kingdom. He has received international recognition as the first to isolate the trachoma virus. Attended Third International Meeting of Biological Standardization in Yugoslavia, 1957. Research: virology, especially yellow fever, trachoma and influenza; and serums and vaccines. Born: 1889.

TENG Chia-tung, Dr.—Hematology; capable doctor of considerable ability. Director, Institute of Blood Transfusion and Hematology, Academy of Medical Sciences, since 1958. Chairman, Department of Hematology (1957) and chairman, Department of Medicine, about 1952–56, China Union Medical College. Served on Committee for Interflow of Native and Western Medicine, China Medical Association, in 1953. Attended school in the United States. Leader of Chinese scientific delegation to Czechoslovakia and the United Arab Republic in 1958. Research: diseases of the blood and high blood-pressure. Born: about 1910.

TSANG Yu-chuan, Dr.—Neuroanatomy; the leading brain and nerve specialist in China. Chairman, Department of Anatomy, Peiping Medical College, since at least

1952. Lecturer, China Union Medical College, in 1955. Member: Scientific Committee, Institute of Psychology, AS; board of directors, China Society of Anatomy. Educated in the United States, where he studied under Dr. C. J. Herrick and Dr. K. S. Lashley. Research: morphological psychology, and brain anatomy utilizing Pavlov's theories. Born: 1902.

WANG Ying-lai (3769/2019/4202), Dr.—Biochemistry; an excellent researcher who gained his reputation as a result of his work on vitamins. Director, Institute of Biochemistry, AS, since 1958. Deputy director, Institute of Physiology and Biochemistry, AS, about 1952–58. Member: Department of Biology, AS; Communist Party of China. Chairman, Chinese National Committee of Biochemistry. Spent seven years in England as a researcher at Cambridge University. Attended Third International Congress of Biochemistry, held in Brussels, 1955. Visited the U.S.S.R. in 1958. Research: vitamins and nutrition. Born: about 1910.

WEI Hsi (7614/2569), Dr.—Virology; reputed to be the foremost Chinese microbiologist. Assistant director, Dairen Institute of Biologicals, since 1949. Chairman, Department of Bacteriology, Dairen Medical College, in 1953. Member: Department of Biology and Earth Sciences, AS. Chairman, China Microbiological Society. Vice chairman, China Medical Society. Received meritorious service award for work performed with U.S. Typhus Commission (renounced this award in 1952 during bacteriological warfare investigation). Decorated by North Korean Government for service in combatting alleged U.S. bacteriological warfare on Korean front. Served on International Scientific Commission for the Investigation of the Facts Concerning Bacteriological Warfare in Korea, 1952. Educated in the United States and spent two years (1951–52) in North Korea. Visited Rumania in 1955. Research: vaccines and serums, rickettsial diseases. Born: about 1903.

WU Ying-kai (0702/5391/1956), Dr.—Surgery; the foremost specialist in thoracic surgery in Communist China. Chief, Surgery Department, China Union Medical College, since at least 1956. Chief, Institute of Chest Diseases, Academy of Military Medical Sciences, CPLA, since 1948. Member: Department of Biology and Earth Sciences, AS; International Society of Surgeons; and Executive Council, China Medical Association. Named an honorary member of the Surgical Association of the U.S.S.R. in 1956, and of the Pirogov Society of Surgeons of the U.S.S.R. in 1959. Educated in the United States. Has visited the U.S.S.R. in 1955 and 1956. Attended Congress of International Surgical Society in Mexico (1957), and has visited Hungary (1953), Sweden (1958), and the Netherlands (1958). Research: chest and cardiac surgery, and casualty surgery. Born: 1910.

2. Veterinary sciences

a. GENERAL

(1) *Capabilities and trends* — Communist China's appreciation of the importance of augmenting livestock production for indigenous consumption, as well as for its value as an export commodity, has stimulated rapid advances in research and investigation related to animal health protection. While China's veterinary research does not approach the detail and refinement evident in Japan's efforts, the country is making progress comparable in many respects to that underway over a much longer period in India. Strong central control is exercised by the government and by the Chinese Academy of Agricultural Sciences (*Chung-kuo Nung-yeh K'o-hsueh-yuan*) over the provincial or regional veterinary research programs, and the emphasis is placed on applied rather than on fundamental research. Much of the work designated as research by China's veterinary authorities is, in reality, a synoptic analysis of work accomplished elsewhere, with strong emphasis on that from Soviet sources.

The number of educational and primary research institutions has remained substantially static after the initial expansion of facilities when the Communist government was established; however, equipment, facilities, and personnel are being progressively expanded and supporting regional laboratories and biological production units, most of which are integrated with the national veterinary research plans, are being rapidly developed in many areas. FIGURE 76–30 is a map showing the location of veterinary research and training installations in Communist China in 1957. Since mainland China was virtually destitute of qualified veterinarians little more than ten years ago, the normal process of developing disciplined and experienced veterinary research personnel will require considerable effort over a period of several years. While educational preparation for veterinary research has been relatively active, more emphasis has been placed on training veterinary personnel at the technician and field service level.

During the First Five Year Plan, agriculture in general suffered financially at the expense of all-out support for industrial expansion, but more funds are now being allocated to support increased food production enterprises. The Communist authorities recognize the importance of veterinary research as a means of augmenting livestock production and, although the actual funds devoted to its development are not known, the recent rapid expansion of auxiliary research facilities and equipment indicate strong financial support.

China's veterinary researchers are actively participating in international scientific meetings and symposiums, chiefly within the countries of the Soviet sphere of influence; but recently a growing number have ventured into other areas as observers. The government also has sent veterinary experts to southeast Asian areas as technical advisors in assistance programs. In consideration of the acute shortage in its own veterinary research force, this action is apparently primarily a propaganda measure.

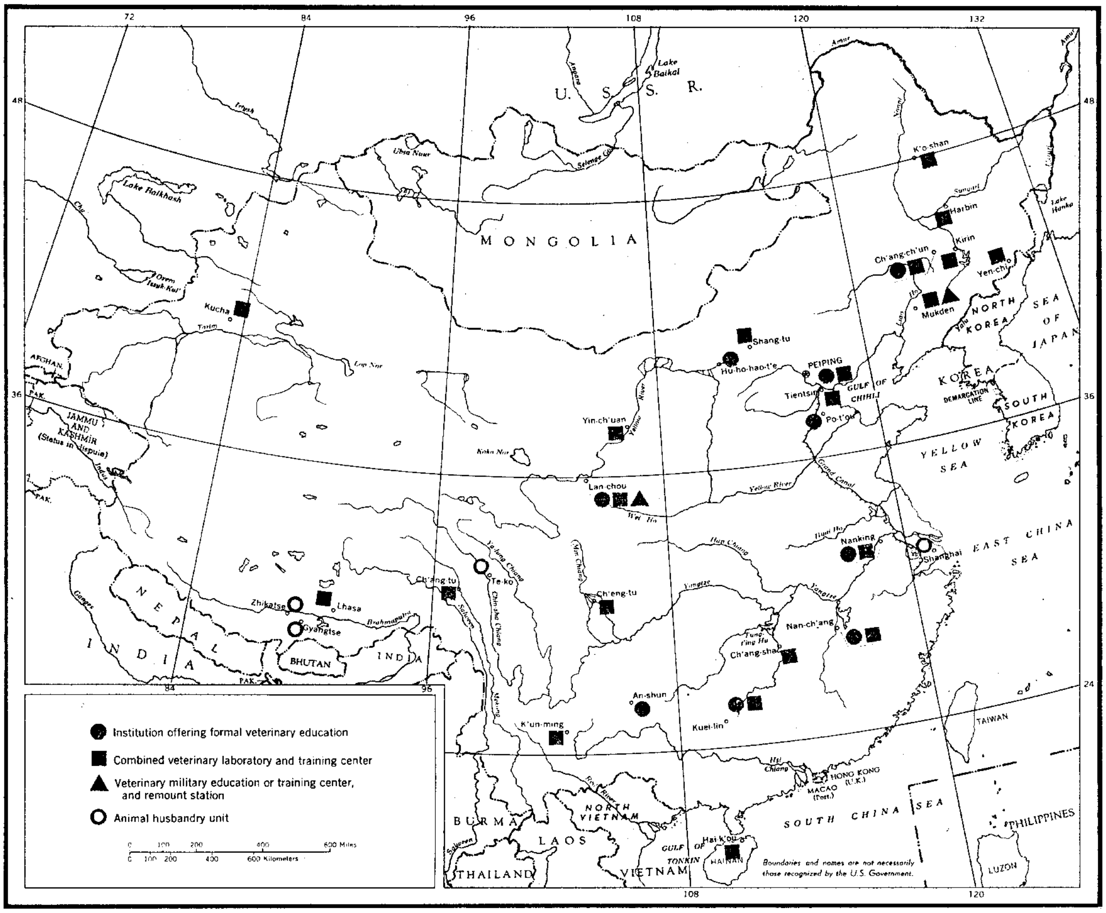

FIGURE 76–30. VETERINARY RESEARCH AND TRAINING INSTALLATIONS, COMMUNIST CHINA, 1957

(2) *Background and organization* — The ancient heritage of "traditional veterinary medicine," which had gradually deteriorated in modern times, is encouraged and blended with the stimulation of contemporary scientific veterinary medicine in China today. The importance of effective animal disease control as a factor in increased production, vividly demonstrated by the former Japanese puppet regime in northeast China and Inner Mongolia, has been recognized generally throughout mainland China.

Veterinary laboratories in Mukden, Ch'ang-ch'un, and Tsingtao were established and were elaborately equipped by the Japanese. These installations are known to be in operation currently, but references to additional modern equipment and details of the type of research underway are lacking. The present government has established veterinary research institutes in 25 provinces, such as those in Szechwan, Hupeh, Kwangsi, Yünnan, Kweichow, Kiangsi, Shansi and Honan, but little information is available regarding their facilities and the character of their research. Brief references are made also to "brotherly" veterinary research and biological production assistance to Tibet. A serum and vaccine plant recently has been established in Lhasa.

The quantitative advances in application of all forms of animal disease control measures during the past decade are phenomenal, and implementation of qualitative advances in modern disease investigations and research is obviously beginning. Since neither the Japanese, in China's occupied areas, nor the pre-World War II governments in mainland areas made any substantial effort toward training native veterinarians beyond the technical level, the country was faced with a postwar situation in which less than 20 qualified

Chinese veterinarians were available to direct and supervise a vast and disrupted veterinary system.

After World War II, China was dependent on relief organizations, chiefly UNRRA, for development of emergency disease control programs, which included rebuilding and augmenting biological production facilities. Plans were only partially implemented by 1948, but the new government in mainland China immediately took up the task of veterinary education, organization of field services, and expansion of laboratory, research and biological facilities. To carry on minimum animal disease control measures and provide national veterinary educational requirements, China has and will continue for some time to be dependent on Soviet technical training and assistance.

b. MAJOR RESEARCH AND DEVELOPMENT — Details of veterinary research in the People's Republic of China are reported superficially in available scientific publications and translations. Veterinary research periodicals issued in recent years apparently avoid the inclusion of exaggerated research successes for propaganda purposes, common in various reports on China's veterinary achievements published in Soviet scientific journals and elsewhere.

Only a few veterinary research projects in China are significant. Among these, the investigations to determine the types and attenuation levels of rinderpest vaccines are the most outstanding. While these studies follow closely the work of Nakamura of Japan and other researchers in Africa, China's research veterinarians have applied studies of vaccinal susceptibility to different types of cattle using avianized, lapinized, lapinized-ovinized, and ovinized vaccines. Various virus strains and various passage or back passage levels have been worked out to produce vaccine conferring solid immunity, without undue reaction to the type of bovine for which its use is intended. This is a major achievement, since one of the most serious obstacles in rinderpest control and eradication has been the objection by livestock raisers to severe or debilitating vaccinal reaction.

Research in hog cholera, probably China's most serious livestock disease, recently has resulted in the expanded use of modified attenuated vaccines which produce more durable and longer lasting immunity than the crystal violet vaccine commonly used in China in the past. Details regarding the methods of modification are not revealed, and it appears likely that the modification hosts are rabbits and that much of the vaccine is produced fresh in the field for immediate use. References are made to lyophilization to preserve and extend the viability of this type of vaccine. Apparently, researchers have not succeeded in stabilizing the vaccine for use under adverse conditions, since reports indicate that at least 30% of the vaccinated pigs in Communist China, particularly those in remote areas, are still immunized with crystal violet vaccine.

Glanders in equines, caused by *Malleomyces mallei* and particularly serious in northern areas, has been the subject of considerable experimentation. Since this disease, both the chronic and acute forms, is much too prevalent to eradicate by a test and slaughter program, Chinese veterinarians have employed methods of treatment. Recent reports indicate a combined sulfamethazine and mallein treatment resulted in recovery of an estimated 75% in animals recently affected, but a much lower recovery rate in those chronically affected over a long period. Researchers comment that recovery resulting from this type of treatment is less spectacular in China than that reported in Iran, where similar work has been attempted. Other countries have reported doubtful value in the use of sulfonamides, mallein, or combinations of these therapeutic materials.

Foot-and-mouth disease, reportedly causing serious losses in recent years, is being increasingly investigated. Virus types "A" and "O" have been identified and a reported new type designated "ZB" (China Bao-shan) is said to occur in southwest China. This may be identical to the Asia type "I" isolated in other nearby southeast Asian countries. This work reportedly is accomplished with Soviet assistance, with the actual typing probably accomplished in Soviet institutions. Foot-and-mouth disease research has resulted in the establishment of at least one major foot-and-mouth disease biological production station in Pao-shan (Yünnan Province), and in activation of several vaccine production units in northeast China.

Other veterinary research of significant interest is the identification of newly discovered animal parasite species. These investigations are relatively recent, and it is too early to determine if this important research is to be actively pursued. Another phase of veterinary research is directed toward evaluation of the effect and practicability of simultaneous immunization with combined vaccines. Apparently successful results are obtained using simultaneous hog cholera and swine erysipelas vaccines.

c. SIGNIFICANT RESEARCH FACILITIES

East China Agricultural Research Institute (Tung-pei Nung-yeh K'o-hsueh Yen-chiu-so), Veterinary Department, Nanking—Chief: Lo Ch'ing-sheng. This was formerly known as the Central Research Institute of the Bureau of Animal Industry, and as the Central Research Institute of

East China. This institute operates under the Ministry of Agriculture and coordinates with the Academy of Agricultural Sciences. It is the principal veterinary research installation dealing with animal disease problems in about five provinces of the central eastern coastal area. Research work originally stressed development of rinderpest vaccines adaptable for the various breeds of cattle in China. In recent years, research on developing new immunizing agents for swine disease has become important. In nearly all available publications, the trend in research appears directed toward production of more effective vaccines or other biologicals. Buildings and a major part of the equipment for this laboratory were built and provided by UNRRA, but reports describe considerable expansion in facilities and equipment. Basic equipment was adequate for both research and biological production, and it was the first laboratory other than those equipped by the Japanese to have lyophilization apparatus.

Harbin Veterinary Research Institute (*Ha-erh-pin Shou-i Yen-chiu-so*), *Harbin*—Director: Hu Hsiang-pi at least to 1957. This institute, also commonly called the Institute of Veterinary Medicine, the All-China Veterinary Scientific Research Institute, and the Northeast Veterinary Research Institute, was reorganized and renamed in 1956 or 1957. This institute is subordinate to the China Academy of Agricultural Sciences of the Ministry of Agriculture. Veterinary research of this institute is conducted in collaboration with other educational and experimental stations. The principal achievements have been the development of an effective lapinized rinderpest vaccine for cattle and the preparation, in collaboration with the Central Institute of Biologicals, Peiping, of lapinized hog cholera vaccine. Currently, research is in progress on sheep pox biologicals and various adaptations of several types of foot-and-mouth disease vaccine. Tissue culture growth of the foot-and-mouth disease virus is also underway. A special laboratory for the study of national veterinary medicine recently has been established at this, as well as several other, research institutes. Research facilities first developed by the Japanese were among the best in China and, according to reports, these facilities, including equipment, have been progressively augmented and improved by authorities of the current government. The director is reported to be a capable researcher, and work of the institute indicates subordinate personnel are capable in modern veterinary research techniques.

North China Agricultural Research Institute (*Hua-pei Nung-yeh K'o-hsueh Yen-chiu-so*), *Peiping*—Director: Ma Wen-ti'en, at least until 1955. Also known as the Peiping Agricultural Research Institute. This research facility is under direction of the Ministry of Agriculture, and research is coordinated and approved by the Academy of Agricultural Sciences. Two divisions, Veterinary Science and Manufacture of Biologicals, are concerned with veterinary research. These facilities have long done research on glanders testing and treatment, immunology of swine diseases, rinderpest and contagious pleuropneumonia, and the epizootiology of brucellosis and tuberculosis. Current research, particularly by the Manufacture of Biologicals Division, deals principally with lyophilization and other methods of stabilizing vaccines for use under rigorous field conditions. These laboratories were among the three or four best developed under the Japanese occupation. Reports have indicated considerable destruction or looting of equipment during the postwar political upheaval, but recent observations of Soviet and Indian delegations indicate that research and production equipment have been improved, both by acquisitions from abroad and from newly developed items by Chinese communist industry. Technical and professional personnel are reported to have had intensive training both locally and abroad with considerable Soviet assistance.

Northwest Institute of Zootechnics and Veterinary Medicine (*Hsi-pei Ch'u-mu Shou-i Yen-chiu-so*), *Lan-chou*—Director: unknown. This institute is controlled by the Ministry of Agriculture, and research is coordinated and supervised by the Academy of Agricultural Sciences. Research work in this region was formerly conducted by the Northwest Zooveterinary Institute, one of the first veterinary educational institutions established after World War II, and some of the current research is still conducted through collaboration by these two institutions. Early work was primarily devoted to feeding and breeding experiments of livestock indigenous to the Outer Mongolian region. Recently, the trend has been toward research related to control of parasitic diseases and commonly occurring infectious diseases such as lamb dysentery, bradsot, and bovine contagious pleuropneumonia. The original research equipment facilities at Lan-chou were adequate but not elaborate. Reports of Soviet observers indicate that there has been considerable expansion of facilities and refer to new equipment, without specifying type or quality.

d. OUTSTANDING PERSONALITIES

CH'ENG Shao-Ch'iung (4453/4801/6608), Dr.—Veterinary medicine and animal husbandry. One of the most respected and competent veterinarians in China. Director, Bureau of Animal Husbandry and Veterinary Medicine, Ministry of Agriculture. Vice president, Chinese Academy of Agricultural Sciences, 1957. Observer during plenary session of Second National Committee of Chinese People's Political Consultive Conference, 1956. Investigator, 1952, on commission that investigated alleged use by the United States of germ warfare in China and Korea. Director, National Research Bureau of Animal Industry, 1945–48, and chief veterinary scientific advisor to UNRRA veterinary staff, 1946–48. Engaged in research on animal disease control since early 1930's. Professor and head of Department of Animal Husbandry and Veterinary Medicine at National Central University, 1930–31. Active member of the Chinese Animal Husbandry and Veterinary Medicine Society, since 1930. Served as director of food control board, 1947. Studied in the United States at Iowa State University and at Johns Hopkins University. Represented China at the Rinderpest Conference, Kenya, 1948. Member, Chinese Agricultural Delegation to Belgrade, 1957. Pro-Nationalist in 1947, but more interested in scientific work than in political philosophy. Highly respected by colleagues. Speaks English well. Research: Principally on viral immunology. Published several papers on rinderpest. An excellent research administrator. Born: 1901.

FANG Hsiao-wen, Dr.—Veterinary medicine. One of the more capable researchers and more prolific publishers of current veterinary research. Member, Veterinary Biological Products Control Institute, Peiping, 1956–58. Recent research on "braxy" and entero-toxemia, and on clostridial infection in sheep has resulted in development of a combined vaccine. Other research includes studies of caprine contagious pleuropneumonia and, reportedly, the preparation of an aluminum hydroxide absorbed tissue vaccine.

HU Hsiang-pi, Dr.—Veterinary medicine; capable and active researcher. Director: Harbin Veterinary Research Institute, Harbin, at least to 1957. Deputy chairman: Heilungkiang Scientific Work Committee, 1958. Member, commission that investigated alleged use by the United States of germ warfare in Korea and China, 1952. Member, Scientific Committee of AS, 1957. Member, editorial board of *Acta Veterinaria et Zootechnica Sinica* (Acts of Veterinary Science and Zootechnics), 1956. Member, British Royal College of Veterinary Medicine, 1955. Studied at the University of Edinburgh some years ago. Active and capable researcher in the field of vaccine production. Born: 1907.

LO Chi'ang-sheng, Dr.—Veterinary medicine. Considered the best doctor of veterinary medicine in China. Chief, veterinary section, East China Agricultural Scientific Research Institute, Nanking, 1956. Head, Department of Animal Husbandry and Veterinary Medicine, National Central University, Nanking, 1944–47. Studied at Kansas State University. Member, Scientific Committee, Academy of Agricultural Sciences, 1957. Executive director, Chinese Association of Animal Husbandry and Veterinary Medicine, 1945. Studied in the United States prior to World War II. A person of high integrity and respected by faculty and students. Has specialized in infectious diseases of animals and biological production. Born: 1895.

SHENG T'ung-sheng, Dr.—Veterinary bacteriology. Member: Scientific Committee, Academy of Agricultural Sciences, 1957. President, National Veterinary College, Lan-chou, 1947 to at least 1953, and also deputy director, Department of Animal Husbandry. Member, Finance and Economic Committee, Northwest Military and Administrative Committee, 1950–53. Studied at Berlin University prior to World War II. Member, standing committee, Department of Biology, Geology and Geography, AS, 1955. Member, editorial board of *Acta Agriculturae Sinica* (Agricultural Sciences Acts), 1955. Indifferent politically, but intensely interested in his work on animal diseases of China. An excellent orator in English and German, as well as Chinese. Has worked principally in bacteriology, but is credited with the isolation of a paralytic virus of cattle. Born: 1905.

D. Comments on principal sources

The information in this Section is based primarily upon material available in the open literature, and is sufficient generally to support the conclusions contained herein. Some additional information was obtained from classified sources. Evaluations of research programs had to be determined with care, in order to avoid misinterpretations and exaggerated claims of successes for propaganda purposes by the Chinese Communists. Detailed data on research and development were lacking largely due to the fact that Communist China is mainly concerned with production to advance the economy as rapidly as possible, with secondary emphasis, in most cases, being devoted to basic scientific research. Moreover, changes in facilities and personnel are being rapidly undertaken in Communist China, and it is difficult to ascertain properly the extent and scope of the work of various research institutes and the current research projects of important, trained scientists.

The following are considered to be some of the most important sources used in the preparation of this Section:

1. *Acta Astronomica Sinica* (Works of the Astronomical Sciences). Academy of Sciences. Nanking. In Chinese with English titles, various issues.
2. CHANG CH'ING-LIEN. "Communist China's Progress in Inorganic, Organic, and Physical Chemistry in Recent Decades." *Hua-hsueh T'ung-pao* (Chemistry Bulletin), no. 10. 8 October 1959. Peiping.
3. CHAO CHIU-CHANG. "Development of Meteorological Research in China in the Past Decade." *Chi-hsiang Hsueh-pao* (Journal of Meteorology), vol. 30, no. 3. 1959. Peiping. Also, various other issues of the *Journal of Meteorology*.
4. CHEN SHAO DIUN and ALENKOVICH, A. A. "Organization of the Veterinary Service in the People's Republic of China." *Veterinariia* (Veterinary Acts), vol. 36, no. 10. October 1959. Moscow.
5. *Chinese Medical Journal*, various issues.
6. CHU COCHING. "Scientific Expeditions Undertaken by the Academy of Sciences in Recent Years." *Scientia Sinica*, vol. 8, no. 9. 1959.
7. FANG SHIH-CH'ING and CH'ING YUN-SAN. "Preliminary Study of Bottom Material of the East China Sea and the Southern Part of the Yellow Sea." *Oceanologicia et Limnologia Sinica* (Sciences of Oceanology and Limnology), vol. 2, no. 2.
8. HUA LO-KENG. "Research Works in Mathematics in China from 1949–59." *Scientia Sinica*, vol. 8, no. 11. November 1959.
9. *K'o-hsueh T'ung-pao* (Journal of the Chinese Academy of Sciences). Various issues.
10. LYSYUK, V. N. "Geodesy and Cartography in the People's Republic of China." *Geodeziya i Kartografiya* (Geodesy and Cartography), no. 3. 1959. Moscow.
11. *National Medical Journal of China*, various issues.
12. "Ten Years' Progress in Solid State Physics in China." *Scientia Sinica*, vol. 8, no. 11. 1959. Also, other articles in various issues.
13. YU TS'ANG. "Report on Surveying and Cartography." *Ts'e-hui T'ung-pao* (Surveying and Cartography Journal), vol. 4, no. 2. 13 February 1958. Peiping.
14. YUN TZE-CH'IANG. "China's Advances in Chemistry in the Past Decade." *Hua-hsueh Pao* (Journal of Chemistry), vol. 25. no. 5, October 1959. Peiping. Also, various other issues of the *Journal of Chemistry*.

[Note: Page 76-86 was blank]

This publication, issued separately for flexibility in production and use, is one of the integral components in the National Intelligence Survey of comprehensive basic intelligence on this NIS Area.

The standard NIS is divided into the following nine Chapters: I Brief; II Military Geography; III Transportation and Telecommunications; IV Sociological; V Political; VI Economic; VII Scientific; VIII Armed Forces; IX Map and Chart Appraisal.

When appropriate, Chapter discussion is amplified by more detailed treatment in one or more of the following Supplements: I Ports and Naval Facilities; II Coasts and Landing Beaches; III Telecommunications; IV Urban Areas; V Petroleum; VI Communism.

The Section, covering a major subtopic, is the NIS basic unit of production and subsequent maintenance. Each Section is individually classified, indicates the Intelligence Agency primarily responsible for the preparation of the Section, and carries the date on which the responsible Agency approved the material for NIS publication. Sections may be combined and issued as a consolidated element, and may be supplemented by Annexes on special subareas.

The standard NIS includes a Gazetteer of geographic names approved by the United States Board on Geographic Names (issued as a separate volume), and a consolidated biographical reference work, Key Personalities.

World sea areas, in terms of major ocean basins, are treated in the NIS on Marine Climate and Oceanography; each ocean basin subdivision is treated in a Part consisting of three, and under some circumstances four, sections, each of which is issued separately. The NIS program also includes publications on special subjects, e.g., International Communism, which are issued as appropriate.

NIS Areas which have been segmented or combined to reflect fundamental political developments are designated by capital letter suffixes. Certain large NIS units are issued in parts, which are identified by Roman numeral suffixes.

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